TURN THE PAGE TO FIND OUT WHAT IS INSIDE THIS SPECIAL PARIS AIR SHOW ISSUE...

FLIGHT INTERNATIONAL

From Flightglobal

9-15 JUNE 2015

WHAT DOES

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LOOK LIKE?

It looks like departing
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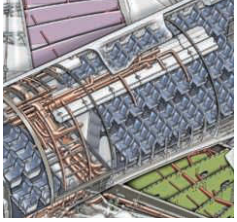
It looks like rapid turnarounds.
Turned around.

It looks like full payloads. Carried.
Hard landings. Made. Short take-offs. Taken.

It looks like ever-changing
flight plans. Going to plan...



UNDER THE TWIN AIRBUS A350-900 DESIGN IN DETAIL FOR LE BOURGET CUTAWAY POSTER

REGIONAL VISION
Turkey confirms plan to enter 70-seat market with jet and turboprop designs via Sierra Nevada pact **22**

FAR AND WIDE
New-generation Falcon rolls out, as Dassault looks to dominate with 'game changing' 5X **37**

FLIGHT INTERNATIONAL

From Flightglobal

9-15 JUNE 2015

PARIS 15

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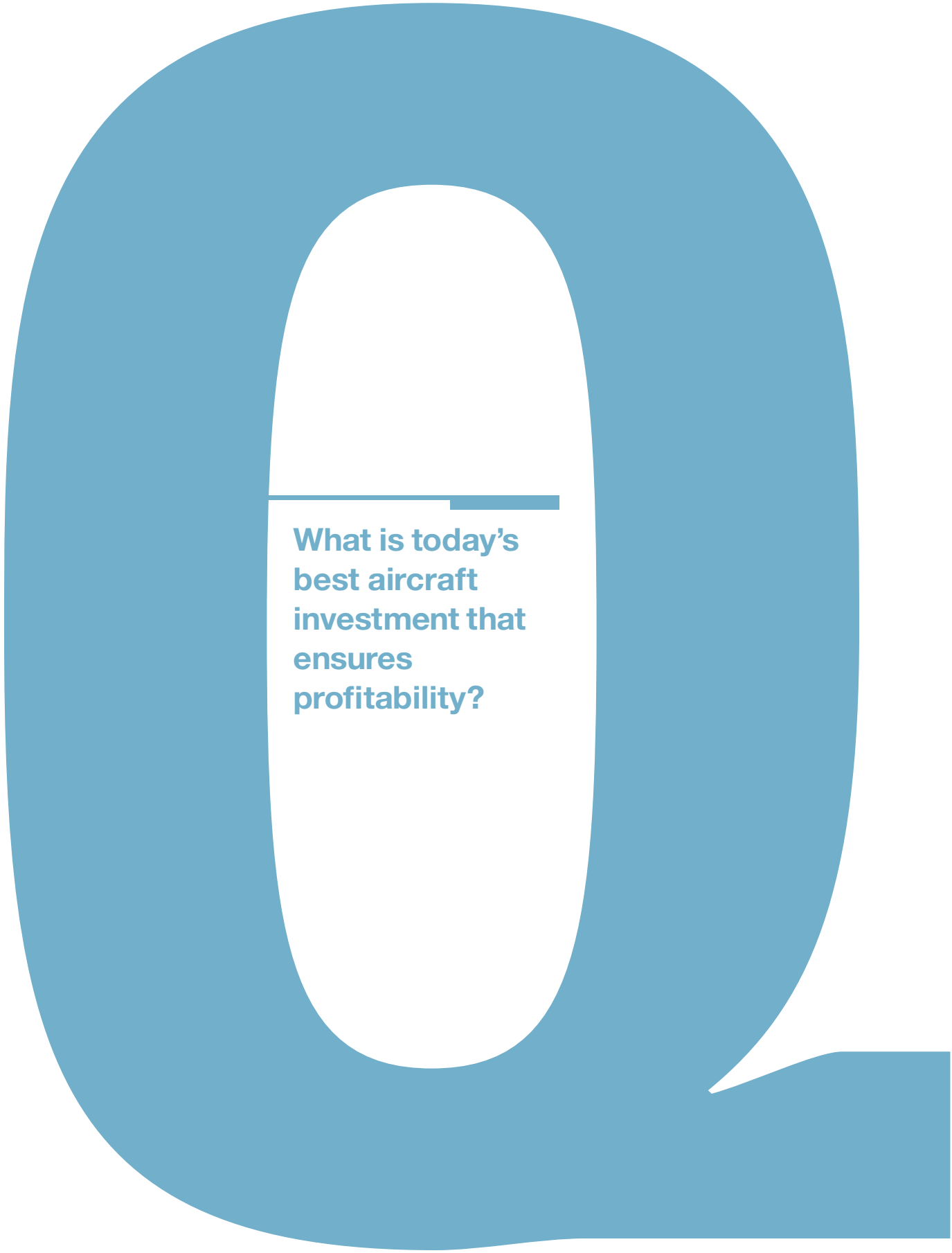

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VOLUME 187 NUMBER 5492

9-15 JUNE 2015

Gary Redford represented by MeiKlephn

COVER IMAGE

UK artist Gary Redford created our retro-themed Paris air show cover, with Dassault's Rafale as the centrepiece. Our preview coverage starts on P42

BillyPix

BEHIND THE HEADLINES

Kate Sarsfield attended the glitzy roll-out of **Dassault's** newest business jet offering, the **5X**, at the company's site in **Bordeaux-Mérignac** (P37). Elsewhere, our reporting team travelled far and wide to prepare our **special report** for the **Paris air show** (P42)

BillyPix

NEXT WEEK FRANCE

Our French industry special will provide updates on projects including Thales's unmanned Watchkeeper

NEWS

THIS WEEK

AIR TRANSPORT

DEFENCE

BUSINESS AVIATION

NEWS FOCUS

Us Air Force

Improving key sensors should be priority for F-35 P11

COVER STORY

REGULARS

Airbus/ US Air Force

Weight is over as Delta accepts first 242t A330-300 P19. Bell eyes Huey replacement opportunity P34

IMAGE OF THE WEEK

Denver, Colorado-based Frontier Airlines has placed a fresh order for 10 Airbus A321s and two current-generation A320s; all to be equipped with sharklet wingtips. Flightglobal's Ascend Fleets database shows the carrier's current assets as including 34 A319s and 22 A320s

View more great aviation shots online and in our weekly tablet edition:

flightglobal.com/flight-international

Airbus

THE WEEK IN NUMBERS

27%

Financial Times; ft.com

Saudi defence spending will rise sharply to $62bn by 2020, making it the world's fifth-largest military spender

$1.32bn

Flightglobal dashboard

The value of financing deals arranged in 2014 by lender PEFCO for eight airliners – an average of $165m each

1

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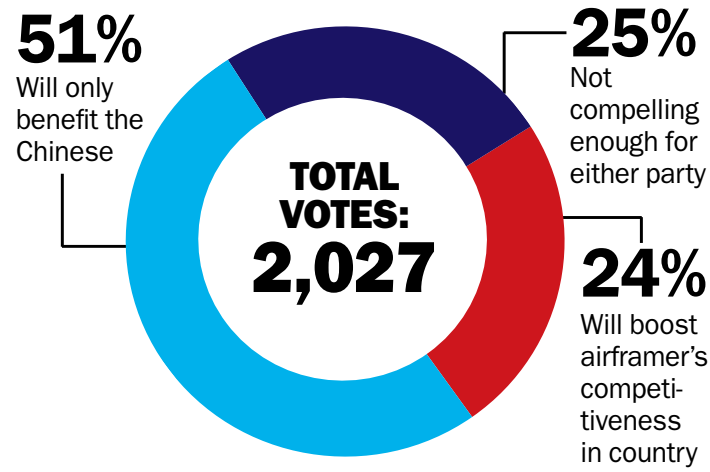
The number of CEOs at tour operator TUI after joint chief Peter Long's departure leaves Fritz Joussen in sole charge

QUESTION OF THE WEEK

Last week, we asked:
Boeing's plans for a 737 completions centre in China? You said:



This week, we ask: **Paris 2015:**
❑ Expect some big surprises
❑ Business as usual ❑ Will be a bit flat
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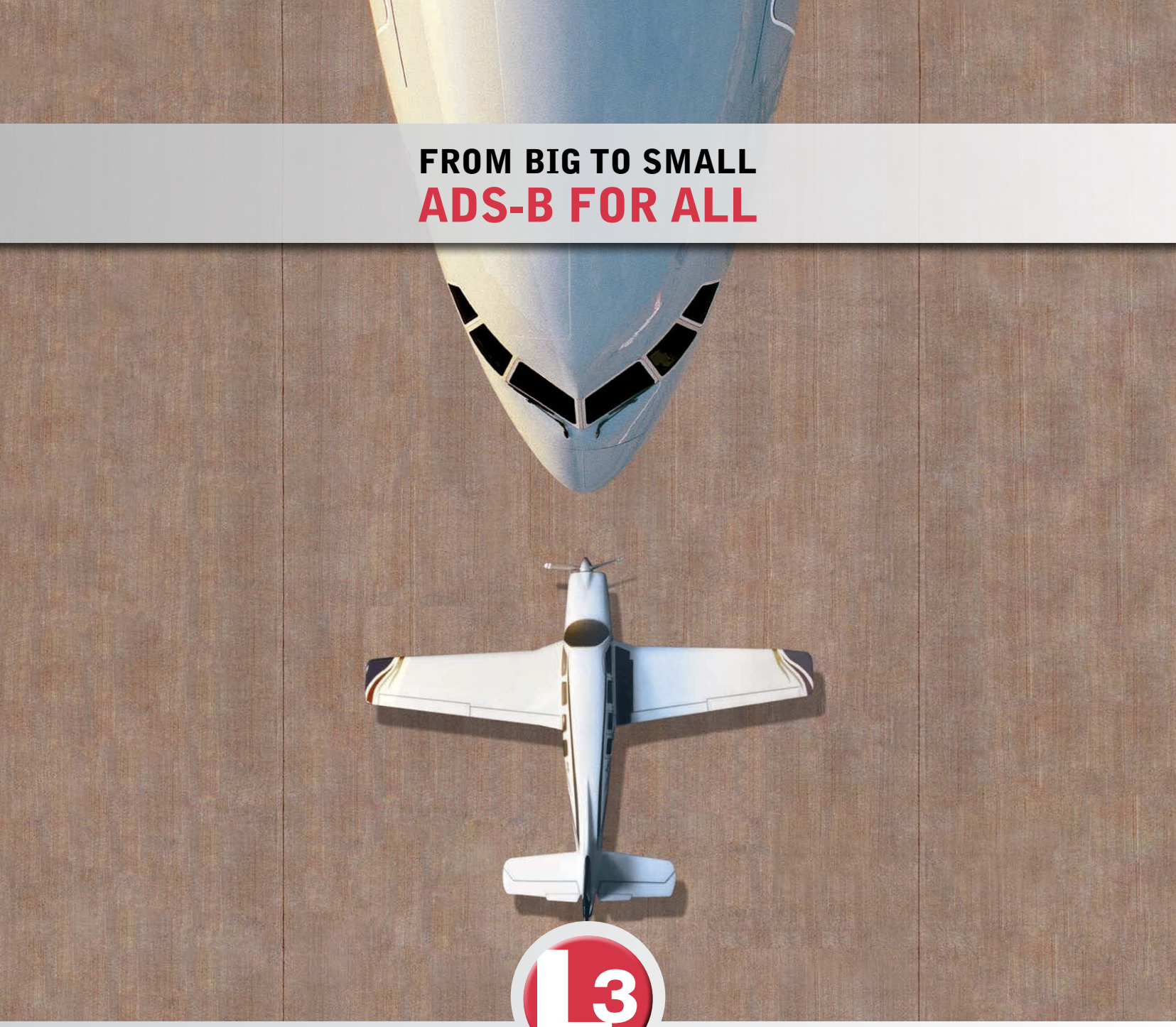
ADS-B FOR ALL



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A spot of bother

F-35 programme watchers are familiar with the odd schedule and capability delay hindering the fifth-generation type. But when the mighty US Air Force speaks out, something is amiss

More than $100 billion has already been spent on developing, testing, fixing and producing about 130 Lockheed Martin F-35s for the US government. In a few weeks or months, the US taxpayer also will have the first 10 combat-ready F-35Bs for that investment.

The nearly 14-year-old Joint Strike Fighter programme involves numbers that skew perspective. Is $100 billion too expensive for such a return? Consider that the US Air Force invested about $62 billion to develop and field about 180 Lockheed F-22s. But the F-35 comes in three different variants, including the world's first operational (almost) supersonic, stealthy and short take-off and vertical landing fighter.

Perhaps the combined capability offered by the F-35 family of fifth-generation fighters is worth American taxpayers' largesse. But when certain key capabilities are deferred the programme invites close scrutiny because of the mountain of cash it has absorbed.

Lockheed and programme officials have long touted the F-35's surveillance capability

On 1 June, Gen Herbert "Hawk" Carlisle, chief of the US Air Force's Air Combat Command, sounded desperate. He is concerned that an upgraded electro-optical targeting system and a "Big SAR" mode for the Northrop Grumman APG-81 active electronically scanned array (AESA) radar could drift beyond the Block 4 version of the F-35 that is scheduled to appear in about five years.

Lockheed and programme officials have long touted the F-35's impressive surveillance capability. As the first aircraft to package an AESA radar, visual targeting system and advanced electronic warfare system into a stealthy airframe, the F-35 is indeed an impressive intelligence-gathering machine. But there is some fine print that undermines those claims, and the "Big SAR" mode is an excellent example. It colloquially describes a wide-area surveillance mode for the APG-81. This currently has a narrowbeam synthetic aperture radar mode – but one of Carlisle's highest priorities is to make sure a wide-area mode does not slip past Block 4.

Rex Features

The operational version will be much better

That's where the story starts to get interesting. In 2007, *Flight International* reported that Lockheed had agreed to deliver a "Big SAR" capability with the Block 3 version of the F-35, then scheduled to be available in 2013. Subsequent delays, however, postponed an initial version of that standard – dubbed Block 3I – to 2016, with the full capability of Block 3F to arrive by the end of 2017. At the same time, the programme office allowed Lockheed to defer key capabilities, such as the Big SAR mode, to the Block 4 configuration.

For $100 billion, Carlisle should get what he needs. ■

See This Week P11, Feature P78

Widening the gap

The industry got its first glimpse of the all-new and eagerly-anticipated Falcon 5X at a dedicated roll-out ceremony on 2 June.

Dassault's first clean-sheet design for more than a decade is a triumph. So too is its strategy to make this impressive wide-cabin business jet the benchmark for a family of new-generation Falcons.

With a cabin 2.58m (8.5ft) wide and 1.98m high, the 5X has the largest internal cross section of any traditional business jet on the market today – greater than its sector rivals the Bombardier Global 5000, Gulfstream G450 and in-development G500.

It is bigger even than the G650 and the developmental Global 7000 and 8000 – all positioned at the top end of the ultra-long-range sector where Dassault will eventually stake a claim.

In an industry where passenger comfort and personal space are the holy grail, the 5X and its subsequent wide-cabin stablemates will provide a compelling option for discerning business jet customers, who today are demanding the same levels of comfort and innovation in their aircraft as they have in their homes.

The 5X is blazing a trail in the $40 million to $50 million large-cabin market. In a sector dominated – for the time being at least – by derivatives of designs that emerged in the 1980s and 1990s, the success of this modern, fresh and innovative aircraft is guaranteed. ■

See Business Aviation P37

For more coverage about the F-35 and other military aircraft programmes, go online at **flightglobal.com/defence**

BRIEFING

MORE DETAILS EMERGE ON A330 POWER-LOSS EVENT

INCIDENT French investigators have revealed further details of a power-loss event during cruise involving a Singapore Airlines Airbus A330-300 (9V-SSF) in May. The aircraft had been operating at 39,000ft, says investigation authority BEA, when the port-side Rolls-Royce Trent 700 powerplant "stalled and self-recovered". BEA states the starboard engine then "stalled". The left-hand powerplant was shut down, it adds, and the aircraft descended to 26,000ft. Relight of the port engine was "successful", says BEA. The aircraft, with 194 occupants, landed at Shanghai without further incident.

PACIFIC WEATHER GROUNDS SOLAR IMPULSE

TECHNOLOGY A "dangerous" Pacific cold front forced the Solar Impulse round-the-world flight attempt to abort a planned five-day leg from Nanjing to Hawaii after 44h with a stop in Nagoya. The solar-powered single-seater has the wingspan of a jumbo jet and is a fragile machine – ground crew will need a week to repair aileron damage caused by gusty winds after landing.

DEBRIS CLEANUP MISSION TARGETS 2021 LAUNCH

SPACEFLIGHT European Space Agency engineers are devising a space debris clean-up mission they hope to launch in 2021. If approved this December, the e.Deorbit effort will use robotic arms or nets mounted on an adapted Vega rocket upper stage to capture a derelict satellite in low-Earth orbit and pull it into the atmosphere, where it would safely burn up. Large debris in low orbits pose an increasing collision threat to crewed and uncrewed missions.

AIRBUS HIRES SILICON VALLEY TOP GUNS

INVESTMENT In a two-pronged move into Silicon Valley, Airbus has established a venture capital fund armed with an initial $150 million and hired a former head of Google Advanced Technology and Projects to head its own innovation centre. Airbus Group Ventures boss Tom Dombrowski is an investments veteran who has worked for Sikorsky, and Paul Eremenko has worked for Google, Motorola and the US Defense Advanced Research Projects Agency. Both report directly to chief executive Tom Enders, who says the "initiatives are key elements in [our] global transformation".

HOGAN LABELS US BIG THREE AS HYPOCRITES

LEGAL Etihad Airways has hit back at the three US mainline carriers involved in the ongoing subsidies dispute, with chief executive James Hogan accusing them of "hypocrisy". Abu Dhabi-based Etihad was responding formally to a US government probe into alleged state support. "Etihad Airways did not seek this fight," says Hogan in a cover letter accompanying Etihad's 60-page submission. "However, we could not stand by idly while these three US airlines and their numerous airline-funded proxy groups attempted to malign us." Etihad's US rivals have enjoyed the "benefits" of Chapter 11 bankruptcy protection, he notes.

PORTUGAL PRESSES COURT TO RESTART TAP SALE

AIRLINES Portugal's government intends to present a "sustained resolution" to contest a court decision ordering suspension of the sale of a stake in flag carrier TAP. Its resolution, based on a public-interest argument, will allow the "process to be carried on", says a government source. Earlier this month, a court order suspended the sale on the grounds that the government had failed to contract two independent institutions to make a financial evaluation of the airline.

Airbus Helicopters

Initial grounds runs of the 5.5-6t rotorcraft have been performed

MILESTONE **DOMINIC PERRY** LONDON

First flight nears as H160 rolls out

Development of new medium-class helicopter "progressing well" with airframer hopeful of accelerating delivery timeline

Airbus Helicopters is closing in on the maiden sortie of its new H160 medium-class rotorcraft, with the roll-out of the initial flight-test prototype taking place at its Marigane, France facility on 28 May.

The new H160 also performed ground runs, says the airframer, and first flight is scheduled for the "coming weeks".

Dominique Maudet, executive vice-president, global business and services at Airbus Helicopters, says development of the majority-composite rotorcraft is on track. "It's progressing well, absolutely according to the plan," he says. "Entry into service is scheduled for 2018 and first flight should happen in the coming weeks."

The appearance of the initial flight-test article will fuel speculation that the H160 will take to the skies prior to the Paris air show – where Airbus Helicopters will have a mock-up of the new helicopter on display – which begins on 15 June.

However, Maudet plays down the suggestion that it is specifically targeting Le Bourget. "The most important thing is that we fly safely and according to our plan and the performance we want to check."

Airbus Helicopters chief executive Guillaume Faury had previously indicated a willingness to advance the entry-into-service date if the H160 proves sufficiently mature.

Maudet says his boss is still "pushing, and [is] willing to shorten the development time", but with the aircraft yet to fly, it is "too early to say".

"The target is that we go earlier, but let's see when we fly what it's behaviour is, but this is our target," he says.

Although the initial prototype is equipped with Pratt & Whitney Canada PW210 turboshafts, later examples will instead have Turbomeca Arrano powerplants, following the airframer's decision in February to opt for a single engine supplier.

Unveiled at the HAI show in March, the 5.5-6t H160 has been in the pipeline since 2013 under its previous X4 guise.

The rapid pace of development has been enabled by the use of two ground-test cells in Marignane to ensure a high level of maturity for the rotorcraft's dynamic components and systems prior to first flight. ■

Engine power loss led to Atlas crash
THIS WEEK P12

CAPABILITY JAMES DREW WASHINGTON DC

USAF demands F-35 sensor upgrades in Block 4 update

Air force general insists long-delayed Big SAR radar and EOTS capability must be delivered

Improving two of the Lockheed Martin F-35's key sensors should be priorities for a future operational standard called Block 4, says a top US Air Force general.

Upgrading the Lockheed electro-optical targeting system (EOTS) and adding a wide-area, high-resolution synthetic aperture radar (SAR) mode – dubbed "Big SAR" – to the Northrop Grumman APG-81 active electronically scanned array are vital, says Air Combat Command chief Gen Herbert Carlisle.

"As we look to the future, the Big SAR and advanced EOTS are the things we have to have on the sensor side," Carlisle told an Air Force Association event in Washington DC.

"The Big SAR radar can't afford to move, and we've got to get to that advanced capability on the EOTS. Those are two that are kind of in the lurch right now [and] the advanced capability on the EOTS is one we're working hard on," Carlisle adds.

In 2007, *Flight International* reported that the Big SAR capability was approved to be introduced as part of the programme's Block 3 standard, which will enter service next year. But that feature has since been delayed until at least Block 4.

US Air Force

Timing for wide-area synthetic aperture radar mode has slipped

The Pentagon is currently deciding which new weapons and capabilities will be integrated with the fifth-generation aircraft beyond those planned for the Block 3F configuration, which represents "full warfighting capability". The subsequent improvements will be rolled out in Block 4, which will be delivered in cycles through the early 2020s.

The USAF is also keeping an eye on software issues discovered during testing, namely the fusion of information from the aircraft's sensor suite. "We've got a way to go," Carlisle says.

Carlisle says improved air-to-air capabilities are vitally important, because the USAF did not buy enough Lockheed F-22 air superiority fighters.

"Probably one of the greatest mistakes was the lack of more F-22s," he says of the decision to end Raptor production early. The service has 180 of the type, but originally planned to acquire 750.

Separately, the US Marine Corps has completed an operational evaluation of the short take-off and vertical landing F-35B, conducted aboard the amphibious assault ship USS *Wasp* late last month. ■

See Feature P78

PROGRAMME
DAVID KAMINSKI-MORROW
TOULOUSE

A350-1000 'on track' but faces tough schedule

Airbus has started work on all three development aircraft for the A350-1000 test campaign, as it expects to begin final assembly in the first quarter of next year.

Head of A350 programme developments Bruno Hernandez says that the -1000 is "on track" but admits bringing the components together to meet the final assembly schedule is "challenging".

Work is under way on the centre wing-box, he says, for all three development aircraft. The rear spar, supplied by GKN Aerospace, entered assembly on 12 May.

At a briefing in Toulouse, Hernandez said Spirit AeroSystems had begun manufacturing panels for the central section 15.

Assembly of the forward fuselage section 13-14 door surrounds – which will be composite, rather than the -900's metallic ones – is also progressing.

Hernandez says structural design maturity has been achieved and systems installation architecture is complete, adding that -1000 production work has started "in all the plants". Pylon assembly is under way while the type's Rolls-Royce Trent XWB-97 powerplant will begin a 120h test campaign on Airbus's A380 flying testbed in October. ■

UNMANNED SYSTEMS DOMINIC PERRY LONDON

Italian trials validate sense-and-avoid technology

Italy's Alenia Aermacchi has successfully validated a sense-and-avoid system designed to allow the integration of unmanned air vehicles into civil airspace.

In a series of recent tests at Grazzanise air base, the company flew multiple sorties using its Sky-Y UAV in conjunction with its C-27J transport.

The Sky-Y was equipped with the Mid-air Collision Avoidance System (MIDCAS), which Alenia has been developing as part of a consortium under a European Defence Agency (EDA) initiative.

To test MIDCAS's ability to identify other aircraft in congested airspace and avoid them, the C-27J was flown as close as 150m (490ft) to the UAV, at different attitudes and in different directions.

Alenia Aermacchi

Alenia's Sky-Y was used to evaluate a range of sensor technology

Additionally, the trials evaluated the best combination of sensors to allow the UAV to build up an accurate picture of the surrounding airspace, including of aircraft not equipped with position transponders.

MIDCAS is a research project contracted by the EDA on behalf of five partner countries – France, Germany, Italy, Spain and Sweden – and featuring industrial and research champions from the various nations. ■

Keep up to date with all the news and pictures from the Paris air show: flightglobal.com/Paris

PROGRAMME **DAVID KAMINSKI-MORROW** TOULOUSE

No rest for Airbus as it ups A380's economics

Airbus is developing a combined crew rest area for the A380 as part of efforts to increase seating capacity on the type.

Programme chief, Didier Evrard, detailed the plan during a recent briefing in Toulouse. Operators are looking for a "more efficient cabin", he says.

By combining the forward flightdeck crew rest area, located behind the cockpit, with the aft underfloor cabin crew rest station, the airframer believes it can free space to install six premium-economy passenger seats. The changes will debut in around 2017.

Use of premium-economy seating and development of 11-abreast layouts are among the strategies Airbus is employing to strengthen the A380's cabin economics. The airframer is pitching the jet with a typical 544-seat arrangement, claiming that a 291-seat Boeing 777-9X – a layout providing similar seating comfort – would have a 23% higher per-seat cash operating cost. "We are focusing on having an A380 which is more attractive, which is – from an economics point-of-view – more efficient, with an optimised cabin," says Airbus chief executive Fabrice Brégier.

He remains upbeat about the A380's prospects, despite acknowledging that the type "is in not such a very positive mood" because the market is "probably a little more limited than what we expected", particularly given that certain customers – notably Transaero and Malaysia Airlines, – are experiencing "difficulties" in their broader operations. ■

See Air Transport P22 and Feature P64

Airbus

High-profile customers are not enough for the flagging programme

Rex Features

Precautionary checks have been advised on engine control units

INVESTIGATION **CRAIG HOYLE** LONDON

Engine power loss led to Atlas crash

Three of tactical transport's four TP400s failed to respond correctly to control inputs shortly after take-off from Seville

Investigators have pinpointed the cause of a fatal accident involving an Airbus A400M tactical transport in Seville, Spain on 9 May as a loss of power to three of its four Europrop International TP400-D6 engines.

Airbus Defence & Space on 2 June communicated the findings of the Spanish defence ministry's CITAAM organisation to operators of the A400M.

"CITAAM confirmed that engines 1, 2 and 3 experienced power frozen after lift-off and did not respond to the crew's attempts to control the power setting in the normal way, whilst engine 4 responded to throttle demands," Airbus says. With the three affected engines still operating at take-off settings, the Airbus test pilots aboard aircraft MSN23 opted to move the power levers to the "flight idle" position. "The power reduced, but then remained at flight idle for the reminder of the flight, despite attempts by the crew to regain power," the company says.

The aircraft crashed as its crew attempted to make an emergency landing near Seville airport. Four of the six-person crew were killed, with the other two seriously injured.

Airbus had on 19 May advised A400M operators France, Germany, Malaysia, Turkey and the UK to perform precautionary checks on the electronic control units for each TP400 engine prior to resuming flight operations. ■

See Feature P86

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DEVELOPMENT **STEPHEN TRIMBLE** WASHINGTON DC

Boeing lifted as Max wings take shape

Airframer begins work on first flight-test example of re-engined 737 narrowbody with maiden sortie scheduled for 2016

With an emphasis on the phrase "on schedule", Boeing has announced that workers in Renton, Washington, have started to assemble the wings of the first 737 Max flight-test aircraft.

The wings of 737 line number 5602 – assigned to the first 737 Max 8 – is taking shape in Renton while Spirit AeroSystems has started to assemble parts for the first fuselage.

Spirit will move the completed assembly by train from Wichita, Kansas, to Renton later this year, where the wings will be joined on a new, dedicated assembly line to support the 737 Max programme.

Boeing overhauled how it manages development programmes in 2012 after the troubled introductions of the 787-8 and 747-8, and the company is keen to show that it has learned from past mistakes with the re-engined narrowbody.

The 737 Max has to meet an ambitious set of performance objectives, including a 14% reduction in specific fuel consumption compared with a 737-800, despite sharing a very similar airframe.

Boeing is introducing the CFM International Leap-1B engines on the 737 Max family, along with a new blended winglet featuring a lift-enhancing ventral stake.

Boeing

Initial wing spars are loaded onto an assembly machine at Renton

But those promises will be evaluated when flight testing begins in 2016. The focus now is keeping the assembly process on schedule, even as 737NG output stabilises at a monthly rate of 42 aircraft per month on two lines. ■

See Air Transport P20

Boeing

FLEET

Vietnam's big twins get airborne

Flight-testing is under way in the USA and Europe of two new-generation widebody twinjet types for Vietnam Airlines. Airbus began testing the first A350-900 for the carrier on 1 June from Toulouse, while its initial 787-9 flew from Boeing's Everett plant on 14 May. Both are due to be delivered in the coming months, making Vietnam Airlines the first airline to operate both the larger Dreamliner variant and the A350. Boeing confirms that Vietnam's 787-9 will perform in the flying display at the Paris air show.

See Features P58, P70

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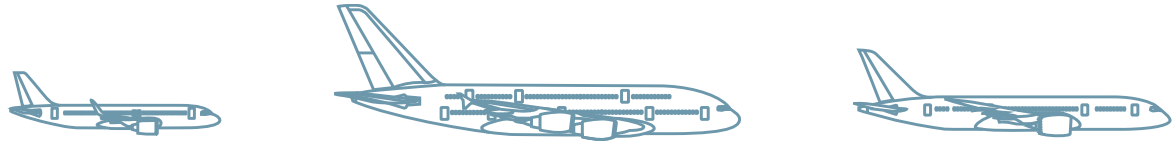


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AIR TRANSPORT P20

MANUFACTURING **DAVID KAMINSKI-MORROW** TOULOUSE

Airbus streamlines A320 wing output

Semi-automated pulse-line to replace static assembly at UK facility as airframer works to hike narrowbody production

Airbus is moving its A320-family wing production concept away from static assembly to a semi-automated pulse-line, to improve efficiency ahead of the transition to A320neo production.

The change is being introduced at the airframer's UK plant at Broughton, which supplies wings to the entire Airbus range.

Airbus is producing A320s at a monthly rate of 42 aircraft, but has committed to raise this to 46 next year and to hike it again, to 50, in 2017.

> **"We don't have the luxury of ramping down and ramping back up"**
>
> **TOM WILLIAMS**
> Chief operating officer, Airbus

Chief operating officer Tom Williams, speaking during a briefing in Toulouse, said that such rates were not envisaged when the A320 wing plant was originally designed.

"If you look at the structural build of the wing box, you'd find something akin to what you'd have found in a shipyard many years ago," he says.

This static system requires multiple components to be moved to a jig, where they are assembled by several personnel. Airbus has accommodated rate increases through a "risk-averse" duplication of the system, says Williams, "until you have 18 jigs all doing the same thing".

"Clearly what we want to do now is to go to a flow-line," he says, adding that Airbus is preparing this for 2017 operations.

"We're going to move to a full flow-line with intelligent application of robots, to take out a lot of the heavy manual drilling and integration problems.

"We think that's going to be a very exciting concept in terms of reducing our manufacturing lead-times and giving us some big improvements in quality."

Airbus is aiming to maintain production rates during the transition to the re-engined A320neo, which is scheduled to enter service this year.

"We don't have the luxury of ramping down and ramping back up," says Williams.

He says the manufacturer is already performing "run at rate" testing – notably for newly-designed parts for the A320neo, such as the pylon – to simulate the full production rates that will be demanded. ■

Airbus

JetBlue Airways will take the first A320 to be produced in the USA

PRODUCTION **STEPHEN TRIMBLE** WASHINGTON DC

Ship sets sail to get Mobile moving

Initial component shipsets for the first A320 to be built in Mobile, Alabama have set sail aboard a cargo container ship bound for Airbus's still under-construction final assembly centre in the US city.

The German-flagged *BBC Fuji* began the 20-day voyage to Mobile on 29 May, with the wings, empennage, rear fuselage section and forward fuselage section of the JetBlue Airways A320 that will be the first aircraft to roll off the new assembly line next year.

The facility will begin assembling the first aircraft within a "few weeks", says Airbus president and chief executive Fabrice Brégier.

Airbus plans to formally open the Mobile plant at the Brookley Field industrial park during a ceremony on 14 September.

The shipment comes as Airbus officials have hinted at plans to expand A320 production beyond 50 aircraft per month after 2016.

The Mobile facility is currently planned to reach a rate of four aircraft per month by 2018, and could grow to eight per month later. ■

DELIVERY

Weight is over for Delta as 242t A330 arrives

Delta Air Lines has taken delivery of the first 242t maximum take-off weight (MTOW) variant of the Airbus A330-300, with the initial example handed over on 28 May.

Aside from the higher MTOW, the long-range twinjet also features a new aerodynamic package, engine improvements and an optional centre fuel tank, increasing range to 6,100nm (11,300km) while cutting fuel burn by up to 2%. Airbus received EASA approval for the upgrade in April, with US Federal Aviation Administration certification following in May.

Atlanta, Georgia-based Delta has a further nine examples of the A330-300 on order, all powered by GE Aviation CF6 engines.

In all, 11 customers have selected the higher-weight option. ■

Airbus

GE Aviation CF6 engines power Delta's fleet of Airbus A330s

PROPULSION **MAX KINGSLEY-JONES** LONDON

Boeing confident on Leap fuel burn

Airframer believes that developmental CFM International engine to power 737 Max will meet performance targets

Boeing's top salesman is confident the CFM International Leap-1B will meet its performance targets, ensuring that the 737 Max will satisfy all the promises made to customers about the re-engined twinjet's efficiency.

CFM engine partner General Electric began the Leap-1B flight-test programme on its 747 flying testbed on 29 April at its centre in Victorville, California. The 5h 30min sortie launched a year-long programme to complete certification in 2016, when the first 737 Max is scheduled to fly.

Amid industry speculation that the -1B engine is behind on fuel-burn targets, Boeing's senior vice-president for global sales and marketing John Wojick tells *Flight International* that CFM "is absolutely tracking to their plan" on the Leap-1B, which exclusively powers the 737 Max.

"We're confident that they're going to be very, very successful in meeting the commitments they made to us, and obviously we'll be able to meet our commitments to our customers on the fuel-burn improvement," he says. "In fact, we're hopeful we'll be able to exceed them."

The Leap-1B features ceramic matrix composite materials in the stage 2 turbine shroud and a fuel nozzle disc produced using additive layer manufacturing. It is expected to deliver a 14% fuel efficiency improvement over the CFM56-powered 737NG.

Boeing

Orders for the re-engined twinjet totalled 2,720 as of 30 April

"Results to date are right in line with what we predicted and where we wanted this engine to be," says Allen Paxson, executive vice-president at CFM International.

The 737 Max is scheduled to enter service in the third quarter of 2017 with launch operator Southwest Airlines.

CFM launched flight testing of the Leap-1C for the Comac C919 in October 2014.

Four months later, the GE-Snecma joint venture confirmed that flight testing of the Leap-1A engine for the Airbus A320neo had started.

Boeing's most recent order figures for the re-engined narrowbody, covering the period until 30 April, show it has accumulated 2,061 orders from 36 confirmed commercial customers, with a further 659 aircraft from as-yet unidentified buyers. ■

MANUFACTURING **MAVIS TOH** SINGAPORE

Mitsubishi turns off aircon to help MRJ production

Mitsubishi Heavy Industries (MHI) has signed an agreement with the government of the southern Japanese city of Matsusaka to allow aircraft component production at its plant in the city, where it currently makes automotive air conditioning systems.

The Japanese industrial giant intends to make Matsusaka a key manufacturing base for the Mitsubishi Regional Jet – including, from March 2017, production of the aircraft's vertical and horizontal stabilisers.

In addition, MHI and the city government have signed a separate pact with a group of local aerospace suppliers, enabling them to use the factory.

The agreement will see MHI allow Aircraft Parts Manufacturing Cooperative (APM) to use its Matsusaka plant.

MHI will also support the group's efforts to establish a "highly efficient and cost-competitive" parts production centre.

This will allow the companies to handle the entire process of small component manufacturing for both the MRJ and also for Boeing aircraft, for which MHI is a tier one supplier.

MHI will also assist the group with obtaining the necessary certifications.

APM aims to start operations in the second half of the 2016 financial year. ■

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DEVELOPMENT **TOLGA OZBEK** ISTANBUL

Turkey lays out its regional ambitions

Ankara-headquartered STM will partner with US firm Sierra Nevada on production of new jet and turboprop aircraft types

US-based Sierra Nevada has signed a memorandum of understanding with the Turkish government covering the development of a new 70-seat regional aircraft in partnership with local manufacturer STM.

There will be jet and turboprop variants – called the TRJ-628 and TR-628 respectively – of the high-wing aircraft. First flight is targeted for 2023 and project partners include Turkish Aerospace Industries, Aselsan, TEI, Havelsan, Kale Aero, Alp Aviation, TSI and Turkish Airlines.

STM says performance specifications for the new aircraft will be "determined during the design and development phases".

As a precursor to the new type, Sierra Nevada intends to produce 50 aircraft based on the Dornier 328. The company acquired its type certificate in February.

Tim Bicheno-Brown

Maiden sortie of the 70-seat TRJ-628 jet is anticipated in 2023

Modernisation of the 328 will involve new engines – again both jet and turboprop – plus a redesigned cockpit. The 30-33-seat aircraft will be used by Turkish Airlines for regional operations, and Turkey's armed forces have shown interest in both variants, which will also be configurable for VIP, ambulance, military or special-mission roles.

The regional jet will be called TRJ-328 and the turboprop the TR-328. STM is to provide engineering support to Sierra Nevada, and will be responsible for manufacturing the aircraft at a purpose-built facility at an as-yet undisclosed location.

First delivery is envisaged around 2018, says Sierra Nevada.

STM lists the TRJ-328 as having a range of 2,010nm (3,720km) and a speed of 405kt (750km/h), and says it will be able to take-off from runways as short as 4,600ft. The TR-328 turboprop version of the aircraft will be able to fly at 335kt, with a range of 1,000nm.

Both aircraft will offer considerable range gains over existing examples, based on the specifications listed by 328 Support Services (*see table*).

As yet, no engine manufacturer has been contracted for the programme. Older Dornier-built models are powered by Pratt & Whitney Canada PW306B jet or PW119C turboprop powerplants.

Sierra Nevada, which will invest in the Turkish manufacturing operation, believes there will be significant regional and international demand for all the new aircraft – and the company also envisages potential sales to US government agencies. ■

CURRENT AND PROPOSED REGIONAL AIRCRAFT SPECIFICATIONS

	328 Jet	328 Turboprop	TRJ-328	TR-328
Range*	900nm	500nm	2,010nm	1,000nm
Speed	400kt	335kt	405kt	335kt
Engine	PW306B	PW119C	N/A	N/A

*NOTE: 32 passenger load SOURCE: STM/328 Support Services

TECHNOLOGY **DAVID KAMINISKI-MORROW** & **MICHAEL GUBISCH** LONDON

Remote control towers gain European interest

Two European nations are to establish remote control tower installations at airports in their jurisdictions as trials of the technology gather pace.

The Irish Aviation Authority has selected Swedish manufacturer Saab to provide its systems at Cork and Shannon airports, which will be operated from a tower centre located at Dublin.

High-definition cameras, meteorological equipment and other data sources will transmit video and other information enabling Dublin-based controllers to direct air traffic at both sites.

The system will contribute to a demonstration and evaluation programme for the technology, carried out under the European Union's Single European Sky initiative. Irish Aviation Authority director of operations Peter Kearney says the "cutting-edge" remote tower will increase operational efficiency.

Meanwhile, German air navigation service provider DFS has selected Austrian technology supplier Frequentis to equip Saarbrucken airport with a remote tower system.

From 2017, control services at the regional gateway in southwestern Germany will be provided from Leipzig, says DFS. It plans to install similar systems at Dresden and Erfurt airports. ■

FLEET **AARON CHONG** KUALA LUMPUR

MAS to offload pair of A380s

Malaysia Airlines (MAS) is actively looking to remove a pair of Airbus A380s from its fleet as part of its restructuring, citing an inability to regularly fill the 494-seat double-deck aicraft.

In a media briefing in Kuala Lumpur on 1 June, the airline's new chief executive Christoph Mueller said MAS has had problems selling out the aircraft since they joined its operation in 2011.

"The world has changed since the A380s were ordered in 2003. Airlines now question if [the type] is still the correct size for the market," he says.

The carrier is now in talks with lessors over the potential disposal of two of its six A380s, either through sale, lease, or a sale-and-leaseback arrangement.

The airline, which from 1 September will be relaunched as Malaysia Airlines Berhad (MAB), will continue to operate its current fleet of 57 Boeing 737-800s and 18 A330s. However, Mueller admits that he is "not sure" of the future of its 13 777-200ERs.

Mueller is targeting breakeven for MAB by 2018. As part of its restructure it will shed around 6,000 of its 20,000-strong workforce – a cut of 30%. ■

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EMPLOYMENT
MICHAEL GUBISCH LONDON

Germany probes UK pilot agency

Prosecutors in Germany are investigating a UK agency that facilitates engagement of self-employed pilots, on suspicion of tax evasion and failure to pay social security contributions.

The public prosecutor's office in Koblenz indicates that the unnamed agency is a supplier to Ryanair, and that the probe encompasses directors of several entities registered in Ireland.

Social security contributions should have been paid according to German rather than Irish or UK regulations

These appear to be pilots who established companies through which to offer their labour. Investigators are attempting to determine whether social security contribution payments were correct and, in the agency's case, whether tax was evaded.

A search of the UK firm's premises has been carried out as part of the enquiry. The investigation relates to Ryanair's employment of pilots at its German bases.

Based on the "current" status of the probe, social security contributions for the flightcrew members in question should have been paid according to German rather than Irish or UK regulations, says chief prosecutor Peter Gandner. ■

AIRLINES GHIM-LAY YEO WASHINGTON DC

Gulf subsidy spat could hit cargo market, FedEx fears

US carriers caught in 'crossfire' would suffer if government moves to amend open skies

Freight carrier FedEx has reiterated a call for the US government to ignore complaints by three of the nation's mainline carriers over alleged subsidies to Gulf rivals, pointing out that any action to amend open skies deals could harm other US airlines.

Writing in a submission to the ongoing probe by three government departments into the impact of the Gulf airlines, FedEx managing director of regulatory affairs Nancy Sparks says: "FedEx has been told repeatedly by representatives of the big three [US airlines] that 'cargo won't be affected'. However, we believe that the risk is real, especially if the US were to proceed with the freeze on new flights."

American Airlines, Delta Air Lines and United Airlines allege that three state-owned Gulf carriers – Emirates Airline, Etihad Airways and Qatar Airways – have received more than $42 billion in subsidies from their governments. The US Departments of Transportation, State and Commerce are currently reviewing those claims and, in the meantime, are facing calls to prevent the Gulf operators from adding new capacity to the USA.

Any such restriction would breach the existing open skies agreements between the USA and the United Arab Emirates and Qatar, says Sparks.

"We believe that we would be caught in the middle as the largest beneficiary of the openness [on] the US side. We just don't see how we could be kept out of the potential crossfire, even if it was not the intent of the big three to involve us."

FedEx

Freight firm operates 44 weekly flights to its Dubai hub

FedEx has a hub at Dubai airport, with 44 flights operating through the facility each week, says Sparks.

"In addition to our own flights, we connect there with 700 weekly flights on 16 airlines and speed US exporters' packages to 46 cities in 41 countries," she adds. This is made possible thanks to the existing US-UAE open skies agreement.

"It is important to note that the Gulf carriers compete vigorously with FedEx in the air cargo arena," says Sparks. "FedEx is accepting the strong competitive challenge that the three Gulf carriers present in the US market. We are not standing by, watching the big three battle those formidable competitors with no risk to our business."

Sparks says FedEx is not seeking to rebut the subsidy allegations. "We will leave that to the Gulf carriers," she says. "If subsidies are found to create competitive harm, the solution is in pricing, not in capacity."

Sparks suggests that if the alleged subsidies are found to create an unfair advantage, a "countervailing duty" could be levied on air fares.

"Then, you let the market decide if those bananas or cars or cell phones are just as attractive at the higher price." ■

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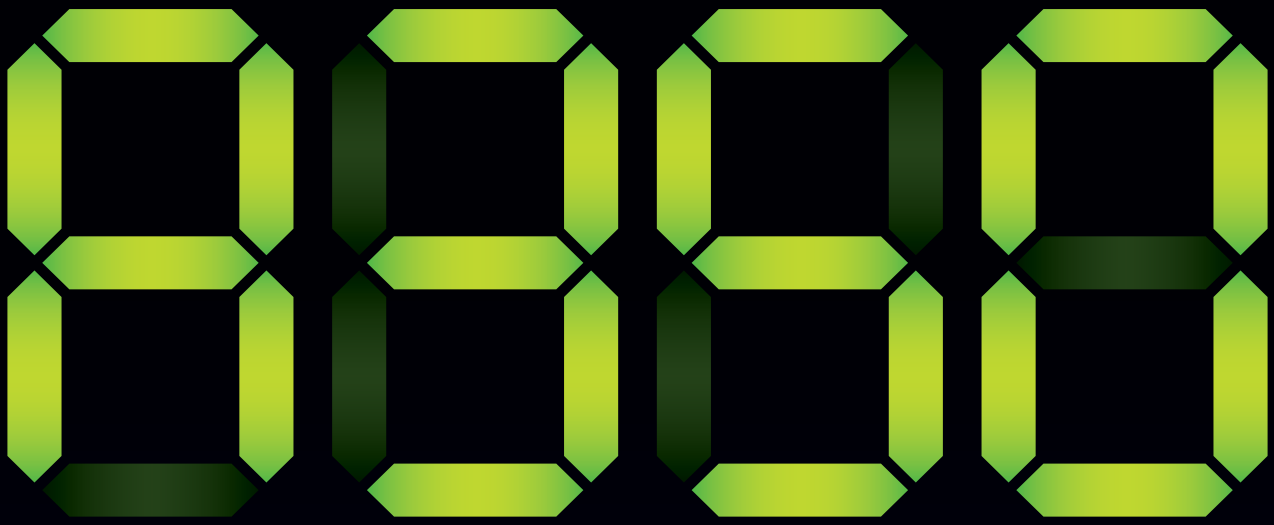

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Boom time begins for KC-46A tanker
DEFENCE P30

FLEET JON HEMMERDINGER WASHINGTON DC

Air Canada lauds 'perfect' Dreamliner

Boeing twinjet praised as "most successful airplane" in carrier's fleet as it presses ahead with long-haul expansion plan

Air Canada executives have praised the performance of its Boeing 787s, describing the twinjet as a perfect fit for the long-haul routes that make up the foundation of the Montreal-based airline's expansion plan.

"This airplane is perfectly designed for everything that we want to do," Air Canada's president of passenger airlines Benjamin Smith said during a 2 June investor day. "If you go back through all the jet aircraft that we have had in the fleet since the early 1960s, I would guess that this is going to be the most successful airplane in our fleet."

Smith's comments came as the carrier announced that its ongoing international expansion plan is delivering better-than-expected results. The success of the strategy has led the company to reduce its cost estimates and increase its projected profit margin through 2018.

Air Canada's chief executive Calin Rovinescu echoes Smith's comments, and calls the 787 perfect for long-haul medium-density routes.

Air Canada's 787 fleet currently includes eight 787-8s. ■

Airteamimages

The airline has an additional 29 of the type on order through 2019

ENHANCEMENT

Green light for Rouge A319 upgrade

Air Canada will install business-class seats and new overhead bins on Airbus A319s operated by its low-cost subsidiary Rouge.

The carrier, which launched Rouge in July 2013, says that by mid-June, Rouge's 20-strong A319 fleet will all be fitted with two-by-two business-class seating. The new configuration will replace the A319's existing premium product, which consists of three-by-three seating with a blocked-off middle berth.

In addition, Air Canada says that this summer it will begin installing new overhead bins in the aircraft – a project that will increase available stowage space by 30%. ■

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DEVELOPMENT **JAMES DREW** WASHINGTON DC

Boom time begins for KC-46A tanker

Key milestone for Boeing as 767-2C completes its debut airworthiness flight with aerial refuelling systems installed

The first engineering and manufacturing development aircraft for Boeing's KC-46A tanker programme has completed its debut airworthiness flight equipped with an aerial refuelling boom and under-wing hose and drogue refuelling pods.

Lasting 4.3h, the flight from Boeing Field to Paine Field in Washington state on 2 June was a milestone for the US Air Force tanker development programme, as it was the first time the 767-2C had been flown with the aerial refuelling equipment installed. The aircraft, EMD-1, returned to the air for the first time since December 2014 on 28 May, prior to the boom and wing pods being fitted.

Boeing says the flights support US Federal Aviation Administration type certification of the 767-2C, and that EMD-1 will now undergo ground tests before being flown again to run through an expanded flight envelope.

This will be completed before a further test later "this summer" when the first true KC-46A test aircraft, EMD-2, will make its flight debut, ahead of entering refuelling system testing with other aircraft. Those flights will inform a milestone C decision, concluding the development phase.

Boeing expects to trial each of the programme's four engineering and manufacturing development aircraft – two 767-2Cs and two KC-46As – this year.

Eighteen 767-based tankers are due to be delivered to the USAF by 2017, with total procurement to cover 176 examples to relieve its oldest Boeing KC-135s by 2027. Boeing also hopes to secure its first international customer for the new model, with a South Korean competition also involving the Airbus Defence & Space A330 multirole tanker/transport being the first major opportunity. ■

See Feature P60

Boeing

Eighteen of the type should be delivered to the air force by 2017

Airbus Helicopters

Airbus Helicopters will produce the H225M at a factory in Lodz

ROTORCRAFT **DOMINIC PERRY** LONDON

New Polish facility set to build Caracals for export

More detail has emerged on Airbus Helicopters' plans to meet the offset requirements of its expected contract with the Polish defence ministry for the supply of 50 H225M Caracals.

Airbus Helicopters will establish a production facility in Lodz to assemble the 11t-class rotorcraft, which are destined for use by all three branches of the Polish armed forces. However, the first 19 aircraft will be manufactured at the airframer's main factory for the type in Marignane, France, says Dominique Maudet, executive vice-president global business and services.

Assuming its contract with Warsaw is finalised in the autumn, Airbus Helicopters will break ground at the new Lodz facility – to be set up in partnership with Polish firm WZL-1 – later this year, says Maudet.

As the first batch of helicopters will be French-built, the company will use the factory to produce an equivalent number of H225Ms for the export market.

"It will really become the Polish helicopter centre," says Maudet. The facility will also in the future offer other design and engineering capabilities, he adds.

Airbus Helicopters is also planning to bid its Tiger for a forthcoming Polish requirement for 32 attack rotorcraft, which it expects to be launched in the middle of the year.

The type will also be assembled at the Lodz site if selected.

Engine supplier Turbomeca will also transfer some production for the Makila turboshafts that power the H225M to a new site in Sędziszów Małopolski, where sister company Hispano-Suiza already has a facility. ■

TRACKING

USAF offered OpenPod sensors for its F-15C fleet

Northrop Grumman has responded to US Air Force interest in adding an infrared search and track (IRST) capability to the Boeing F-15C by unveiling its reconfigurable OpenPod.

The front end of the rail-mounted design can be swapped out between sorties to host either an IRST produced by Italy's Selex ES, or light detection and ranging, targeting or communications payloads. The product draws on "advances in target identification, clutter rejection and tracking from Northrop Grumman's [Lockheed Martin] F-35 distributed aperture system, fire control radar and infrared countermeasures products," says James Mocarski, the company's vice-president of airborne tactical sensors.

The USAF's F-15 division has formally expressed interest in a production-ready IRST capability for fielding in 2018, and in a longer-term development effort to acquire a more advanced system in the 2020 timeframe. This would enable the fighter to "detect, track, target and engage threats in radar-denied environments".

Mocarski says OpenPod is already in flight testing and meeting Northrop's technical and schedule milestones, and its cost objectives. Weighing 226kg (500lb), OpenPod could also be carried by bombers, transports and unmanned air vehicles. ■

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BOEING

ORDNANCE **BETH STEVENSON** LONDON

Multiple stores will toughen Typhoon

UK asks BAE to study feasibility of equipping Eurofighter with smart launcher capable of carrying up to three weapons

BAE Systems has been contracted by the UK Ministry of Defence to carry out a feasibility study into the possibility of adding a common weapon launcher to the Eurofighter Typhoon.

The launcher would be able to carry multiple air-to-surface weapons on one hardpoint, including MBDA's dual-mode seeker-equipped Brimstone 2 missile and Raytheon Systems' Paveway IV precision-guided bomb. The manufacturers of both weapons are also involved in the study.

The common launcher is also currently being assessed to support the MoD's Spear Capability 3 future missile effort, BAE says.

Launched earlier this year and worth £1.7 million ($2.6 million), the study phase is expected to conclude later this month. The activity builds on work performed under a previous MoD study contract placed during 2014.

BAE Systems

The enhancement would boost European type's combat lethality

A decision on the development effort will follow the submission of a report to the MoD on the feasibility of the system. Subject to approval, this will be followed by long lead-time and launcher development phases, with the capability to potentially become operational in 2019.

"Developing a common weapon launcher solution could significantly enhance the Typhoon's ability to deliver increased weapons persistence and effects," says Andy Eddleston, Typhoon product development and future capability director at BAE. "Each launcher could be capable of carrying up to three weapons, providing a great deal of flexibility and persistence for the operator."

The feasibility study award follows a $224 million Phase 3 capability enhancement package contract for the Typhoon, signed in February. Approved by Eurofighter partner nations Germany, Italy, Spain and the UK for delivery from 2017, this contains updates including full integration of Brimstone for the UK Royal Air Force fleet. ■

DEVELOPMENT **JAMES DREW** WASHINGTON DC

USAF seeks replacement for cluster munition use

The US Air Force expects that production of a 226kg (500lb) iron-spraying bomb, among other efforts, will eliminate the need for cluster munitions after 2018.

Although precision-strike weapons are more commonly used today, the head of Air Combat Command Gen Hawk Carlisle says there is still demand for cluster munition capabilities. "The Korean Peninsula is the place with the greatest demand," he says, due to the US's need to deter an attack by the north.

But as a 1 January 2019 deadline approaches for ending the use of cluster munitions, Carlisle says the air force has a "pretty good plan" for replacing them.

"We don't think we'll have any problem meeting the timeline of 2018," he says. "The amount of cluster munitions we talk about in use is pretty small right now."

Carlisle acknowledges an effort to produce a "cast ductile iron" bomb, which would spray fragments over a wide area.

A recent contracting notice seeks a manufacturer to build 30 "Mk 82 Mod 7" iron bomb assemblies, initially with options for three or four follow-on production lots. "Cast ductile iron will decrease the likelihood of unexploded ordnance, while improving lethality," the notice states.

US Air Force

F-16s at Kunsan air base form part of deterrent to North Korea

Meanwhile, the air force has asked US lawmakers to change a law that prohibits the retirement of its Boeing-built conventional air-launched cruise missiles (CALCM), which are being replaced by an extended-range version of Lockheed Martin's Joint Air-to-Surface Standoff Missile.

"We'd be able to do the retirement of the older system," Carlisle says. The USAF estimates that it would save $200 million through 2032 by decommissioning CALCM. ■

See Feature P81

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ROTORCRAFT **JAMES DREW** WASHINGTON DC

Bell eyes Huey replacement chance

Manufacturers target revived $980 million opportunity to provide USAF with new aircraft for missile site protection fleet

Airframers including Bell Helicopter are eyeing a lucrative opportunity to replace the US Air Force's 45-year-old UH-1N Huey fleet currently used to help guard Minuteman III intercontinental ballistic missile sites.

The air force currently plans to establish a $980 million programme to replace its 62-strong Huey fleet, which also includes aircraft that shuttle government officials around Washington DC.

Bell says the requirements as discussed so far point to its UH-1Y Venom combat utility helicopter, which is flown by the US Marine Corps. H-1 business development manager Scott Clifton says the modern Huey has twice the range and three times the carrying capacity of the in-service type, with the potential to transport between eight and 10 passengers.

Alternatively, the company could offer the UH-1Y or Bell 412 for the security and convoy escort mission in the missile fields of Montana, North Dakota and Wyoming, and a customised, commercial Bell 429 to provide a more comfortable ride around the nation's capital.

A fleet of 62 aged UH-1Ns are currently in operation

US Air Force

"It really comes down to what the air force wants," Clifton says. "If they don't mind having multiples, I can fit exactly what they need into an aircraft we already have in production."

Rival types pitched for the requirement include the Airbus Helicopters UH-72A Lakota and Sikorsky UH-60M Black Hawk.

The USAF has made multiple previous attempts to procure a new helicopter, most recently through the common vertical lift support platform programme, which was cancelled in 2012 due to spending cuts.

The service has since been assessing affordable options, and one strategy now being considered would repurpose older US Army UH-60As. Industry, though, contends that a new helicopter would have a lower life-cycle cost and higher availability rate. "You may not need 62 – maybe you could have less," Clifton suggests.

Air force estimates indicate that it would cost $980 million to replace its UH-1Ns with restored Black Hawks, and that amount has been requested in its latest long-term spending plan.

However, the service earlier this year said it would consider all "non-developmental vertical lift aircraft", including civil and parapublic types. Its analysis is expected to conclude in July, with the results to inform a follow-on assessment and final acquisition strategy.

There are currently 25 Hueys assigned to the missile security mission, while the so-called "continuity of government" role is performed by 20 aircraft stationed at Andrews AFB in Maryland.

The USMC completed its phase out of the UH-1N last September, with Bell having delivered about 110 UH-1Ys to date.

Clifton says the marines are purchasing 160 aircraft, and that Bell needs additional US government orders and foreign military sales to extend production into the next decade. ■

SURVEILLANCE **GREG WALDRON** SINGAPORE

Asia scans maritime patrol options

Saab continues to see developing interest in southeast Asia for maritime surveillance and patrol aircraft, with the trend driven by the growing number of submarines being acquired in the region, plus territorial disputes in the South China Sea, piracy and people trafficking.

Saab does not produce dedicated maritime patrol or ASW platforms, but can integrate its Swordfish mission system on fixed-wing aircraft, depending on a client's requirements.

Examples include the Saab 2000 and Bombardier Dash 8 Q400 turboprops, while it also offers the Saab 340-based maritime surveillance aircraft.

Saab

Swordfish mission equipment could be added to the Saab 2000

Beyond surveillance requirements, southeast Asian nations are also curious about arming their maritime patrol aircraft with light torpedoes. Saab, however, says it has not seen great interest from the region in potentially arming such aircraft with other weapons, including guns or missiles. ■

EXPORTS

Japan homes in on Hawkeye buy

The US State Department has approved a potential sale to Japan of four Northrop Grumman E-2D Advanced Hawkeye airborne early warning and control system aircraft. If completed, the acquisition would be worth up to $1.7 billion.

Approval for the request – which was disclosed on 1 June – follows the release of a Japanese budget document last January which included funding for a single E-2D.

The Japan Air Self-Defence Force operates 13 Hawkeyes in the E-2C standard. ■

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Singapore Airshow gears up to set your sights higher

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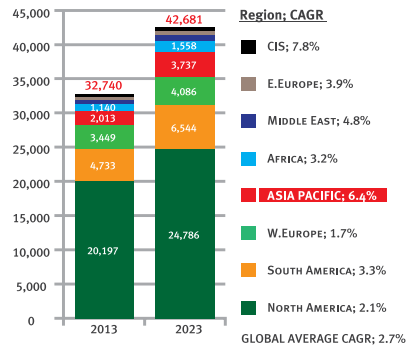
Singapore Airshow, Asia's largest Airshow and one of the most important aerospace and defence exhibitions in the world, is gearing up for its fifth edition and promises to set your sights higher.

To date, 80% of the 2016 edition has been booked and the event will feature its first Business Aviation Zone, offering exciting new spheres of opportunities for the industry.

According to data from the Federal Aviation Administration, the monthly global business aviation flight movements have started to increase in recent years. Demand is picking up and based on figures by ICF International, the global installed business aviation fleet is forecasted to reach over 42,600 aircraft by 2023, a global compound annual growth rate (CAGR) of 2.7% from 2013.

In Asia Pacific alone, the forecasted CAGR over the 10-year period is more than double this figure at a very optimistic growth rate of 6.4%. Compared to the North American fleet, the Asia Pacific fleet is much younger and smaller.

2013 - 2023 Fleet Growth By Region



Source: ICF International

Nonetheless, the industry is sanguine on the growth potential in the Asia Pacific region with the increasing affluence in this region and the liberalisation of the airspace, specifically in China.

Notably, long time exhibitors with the Singapore Airshow such as Bombardier and Cessna have projected strong demand in the long term. Over the next two decades, Bombardier forecasts approximately 1,000 business jet deliveries in Asia Pacific while Cessna has set up a joint service facility with sister company Bell Helicopter at the Seletar Aerospace Park in Singapore to support the South East Asian fleet.

Opportunities abound in the Asia Pacific for Commercial Air Transport

Boosted by recent deliveries to both low cost airlines and national flag carriers, ICF International forecasts that the strong fleet growth in the Asia Pacific region is set to continue.

Accounting for new aircraft deliveries and retirements, the installed fleet in Asia Pacific is expected to grow faster at a compound annual growth rate of 4.3%, more than the global average of 3.1%. By 2023, the Asia Pacific airline fleet will have overtaken North America with approximately 10,380 aircraft in service to be the host of the world's largest fleet.

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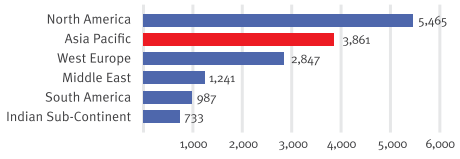
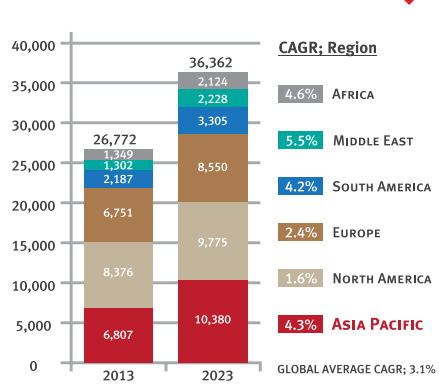
Total Aircraft Deliveries In Selected Regions 2013 - 2023



Commercial Aerospace Fleet Growth 2013 - 2023



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Quest sells first Kodiak through European dealer
BUSINESS AVIATION P38

MILESTONE **KATE SARSFIELD** BORDEAUX

Falcon 5X launches wide-cabin family

Dassault reveals plans for next generation of business aircraft at roll-out ceremony for $45 million, 16-seat twinjet

Dassault rolled out its Falcon 5X on 2 June during a ceremony at its 64-year-old final assembly facility at Bordeaux-Mérignac airport in southwest France.

In front of a specially selected audience of customers, operators, suppliers and regulators, Dassault Aviation chairman and chief executive Éric Trappier declared that the large-cabin, long-range aircraft was not only a "game changer" in this niche sector, but also marked the first of a family of new-generation wide-cabin business jets from the French airframer.

"Cabin width is an integral part of our product line strategy going forward," Trappier says.

With a fuselage diameter of 2.7m (8.9ft) and a cabin height of 1.98m, the 16-passenger 5X is the largest aircraft in Dassault's six-strong high-end business jet family, and boasts the widest cabin cross section of any traditional business jet.

BillyPix

Twin 11,450lb-thrust Snecma Silvercrest engines power Dassault's new long-range, wide-cabin jet

STRETCHED VERSION

The future Falcon family, Trappier says, is likely to include a stretched and longer-range version of the 5X, which will compete at the top end of the market with the ultra-long-range Gulfstream G650 and in-development Bombardier Global 7000 and 8000. He refuses to be drawn, however, on the specific timeline for the launch of this new offering.

"All new programmes, whatever they will be, will have the wider cabin [as standard]," Trappier adds. "However, for now, our priority is to focus on bringing the 5X and [flagship] 8X to market over the next two years."

The 8X trijet – a stretched version of the eight-year old 7X, with a longer range of 6,450nm (12,000km) – was rolled-out in December and is scheduled to enter service next year.

"Once we are in an advanced stage of development [with these programmes], we can release our engineers and designers to work on new projects," Trappier adds.

The 5X was unveiled at the National Business Aviation Association convention and exhibition in October 2013, and is the French airframer's first clean-sheet design since the 7X.

The 5X was originally conceived as a super-midsize business jet – dubbed the Falcon SMS. But following extensive market research and feedback from its "highly valued" customer advisory board, Dassault elected to position this latest design in the large-cabin, long-range sector.

"We didn't want an aircraft in the $20-35 million business jet segment as we felt it would compete with the Falcon 2000LX/S – already a best-selling aircraft in the super-midsize/large-cabin-market and with a long-term future in the Falcon family," says Dassault Falcon Jet president and chief executive John Rosanvallon.

The $45 million 5X fills a gap in Dassault's six-strong product line between the large-cabin Falcon 900LX and the 7X trijet, and is pitched against the Global 5000, G450 and in-development G500 and G600.

The aircraft is powered by two 11,450lb-thrust (51kN) Snecma Silvercrest engines, marking the first time a Falcon has been launched with an all-new powerplant, or one produced by a French manufacturer. The type is projected to have a maximum speed of 370kt (685km/h), a maximum take-off weight of 31,600kg (69,700lb), a range of 5,200nm and an approach speed of 105kt.

> **"Cabin width is an integral part of our product line strategy going forward"**
> **ÉRIC TRAPPIER**
> Chief executive, Dassault Aviation

Other new features include the latest iteration of Dassault's EASy flightdeck, with Elbit Systems' ClearVision enhanced flight vision system, an ultra-efficient wing, advanced digital flight control system derived from the Rafale fighter and a unique window in the ceiling of the cabin, giving a direct view of the sky above.

To help enhance the pilot's view on visual approaches, Dassault has made the 5X cockpit windows around 30% larger than those of other Falcons.

Aerospace analyst Rolland Vincent is confident that Dassault has found a winning formula with the 5X, and believes the Mach 0.90 aircraft will help reinvigorate the large-cabin business jet market. This sector, he says, witnessed a 30% fall in annual deliveries between 2008 and 2011, from which it is still recovering. Vincent predicts deliveries of around 500 new large-cabin, long-range types between 2016-2020 – up about 5% over the prior period. "With Global 5000 production rates being cut back in 2016 and beyond, this will create market space for the 5X," he says.

The aircraft has already been greeted "enthusiastically", Trappier says, by both existing customers and buyers who are new to business aviation. Company patriarch Serge Dassault will be the recipient of one of the early models, he adds.

"We have a healthy orderbook for the 5X from across the globe," agrees Dassault regional sales and marketing director Renaud Cloatre, although he will not be drawn on exact sales numbers. "The aircraft's huge cabin, coupled with its intercontinental range is very appealing," he adds. Like its Falcon stablemates the 5X will also be certificated for steep approaches, allowing it to take off and land from some of the world's most challenging hubs, including London City airport in the UK.

Aircraft serial number one is scheduled to take flight in the third quarter and will be used to open the flight envelope. Three 5Xs will take part in the certification campaign, with entry into service targeted for late 2017 or early 2018. ■

LEADERSHIP **KATE SARSFIELD** LONDON

Hansell stands aside after four years as NetJets boss

Chief executive of fractional ownership provider quits his job with immediate effect

Jordan Hansell has stepped down as chairman and chief executive officer of NetJets with immediate effect. He has been replaced by Adam Johnson, a 20-year veteran of the US-headquartered fractional ownership provider.

Hansell took over the reins at NetJets from David Sokol in 2011. He helped steer the company through the economic crisis that hammered sales of fractionally-owned aircraft and led to the demise of many smaller, yet established fractional ownership ventures such as CitationAir and Avantair.

Under Hansell's stewardship, Berkshire Hathaway-owned NetJets placed orders and options for nearly $10 billion-worth of aircraft from the Bombardier and Cessna stables – continuing a 10-year top-to-tail revamp of the company's 700-strong business jet fleet that began during Sokol's 18-month tenure.

These acquisitions included 275 Challenger 350s and 650s, for which NetJets is launch customer.

Hansell's last public appearance was at the European Business Aviation Convention and Exhibition last month, when he took delivery of the first super-midsize Challenger 350 for NetJets Europe.

His reign had been marred by industrial disputes with the company's pilots, who earlier this year staged a protest at Berkshire Hathaway's annual meeting, as part of a call for better pay and conditions.

"NetJets is very well positioned for future success and to grab hold of the opportunities before it," Hansell said in a departing statement.

Fellow former employee Bill Noe, who has been reappointed to his previous position as president and chief operating officer of the company, will join Johnson on the senior management team. ■

Quest Aircraft

The type seats nine passengers

TURBOPROPS
KATE SARSFIELD LONDON

Quest sells first Kodiak through European dealer

Quest Aircraft has sold its first Kodiak single-engined turboprop through a European dealer.

The €1.9 million ($2 million) Kodiak was sold by German sales agent, Rheinland Air Service, one of around 20 dealerships that Quest has appointed as part of its drive to sell and market the Kodiak through regional, independent companies rather than through US sales agents. ■

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STRATEGY **NIALL O'KEEFFE** ZURICH

SR Technics makes franc admission

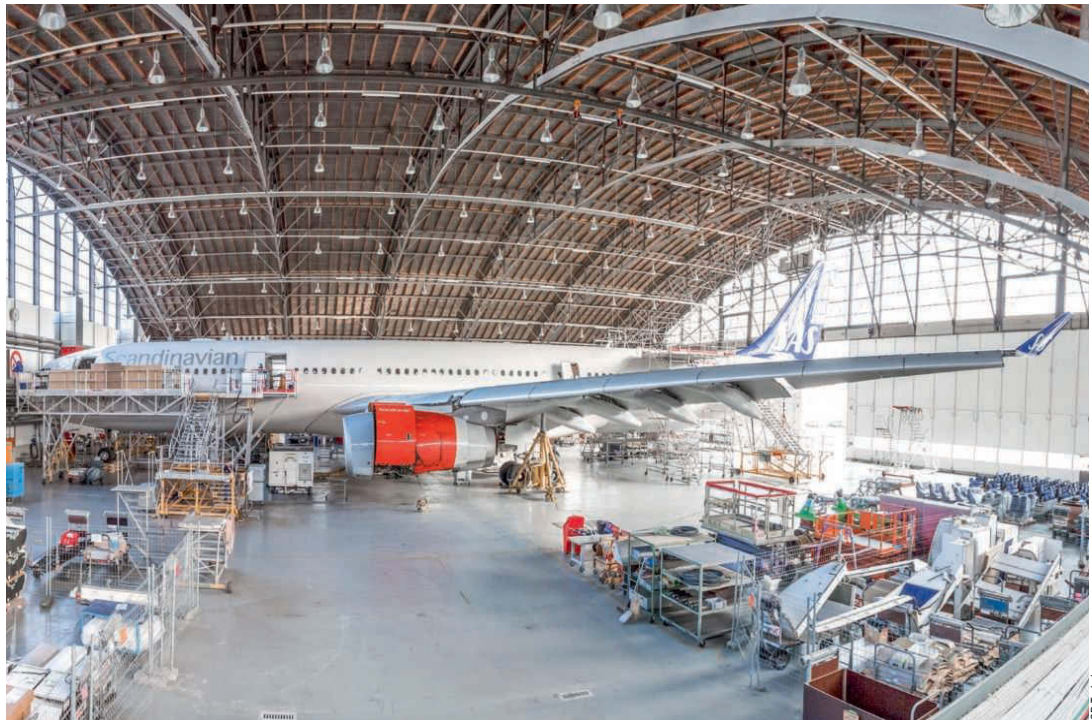
Rising costs caused by appreciating Swiss currency prompt strategic rethink at completions and maintenance provider

Switzerland is a tough place to do business, particularly if you are a late-comer to the VIP completions market. It has a high cost base and several well-established companies operating in the segment, such as Basel-based Jet Aviation and Amac Aerospace.

These pressures, plus the problem of an appreciating Swiss franc inflating its cost base, have prompted Zurich-located SR Technics into a rethink of its airframe services strategy.

The focus at Zurich is now on complex cabin upgrades – which can be combined with routine maintenance – rather than pure MRO or green completions of new business jets.

Senior vice-president of aircraft services Michael Sattler, who joined Mubadala Development Company-owned SR Technics from RUAG in April, sketches the context for the rethink: "The world around us is changing. Unfortunately, in Switzerland it's changing in the wrong direction."



SR Technics

The company is part-way through a cabin refit contract with SAS for the carrier's A330s and A340s

MONEY WOES

He is alluding to the Swiss central bank's sudden decision, in January, to lift its currency cap. This, he says, "makes our services more expensive – and they have not been the cheapest one before". The hit on costs is in the order of 15-20%, he estimates.

Given that airframe MRO is, as Sattler acknowledges, "becoming more and more a commodity", SR Technics has long been required to find "a product where value for money is looked at differently". A decision to pursue green completions was taken in 2010, but this was "maybe a bit too late", Sattler concedes.

"The market had already started to go in a different direction," he says. "There are established players around us who can look back with more experience, more reputation in this area."

Rather than continue battling strong rivals for a small number of available deals, SR Technics' board embarked on a strategic review late last year. The path settled upon lies midway between green completions and pure MRO.

For airlines, SR Technics will offer sophisticated, turnkey cabin modifications. On the business jet-side, green-completions business will not be turned away, but the focus will be on refurbishment of in-service aircraft in parallel with maintenance. SR Technics "can do a heavy check much more efficiently, faster and cheaper than the traditional corporate MRO facilities", argues Sattler.

> **"We truly believe that there is a market for a facility in Zurich where we offer Swiss quality and Swiss precision when it comes to timing"**
>
> **MICHAEL SATTLER**
> Senior vice-president of aircraft services, SR Technics

Low-cost maintenance is meanwhile being carried out at a Malta facility – where EasyJet accounts for some 90% of the volume – while administrative work is conducted at a new site in Serbia.

A contract won from Scandinavia's SAS Group provides a model of SR Technics' ambitions for the Zurich facility. SR Technics is executing a complete cabin refit of four Airbus A330s and four A340s – up from an original three – to include Lufthansa Technik's HelioJet lighting, Panasonic Global Communications Suite connectivity, Zodiac Inflight Innovations' seat-centric in-flight entertainment, Thompson Aero Vantage XL business-class seats, and Weber 5751 economy seats adapted by Zodiac Seats France.

"It's very complex," says Sattler. "It was an opportunity for both of us to learn together." He is hopeful that the learning curve is being traversed to the benefit of future airline customers.

Sattler notes some convergence in the aspirations of airlines and business jet operators. "For a long-range flight, some VIPs prefer to take first class of a good airline [than flying in a business jet] because, actually, the comfort is higher. So we see [that] a good airline cabin and then a VIP cabin on an A330 are not that far away anymore."

SWISS PRECISION

He adds: "We truly believe that there is a market for a facility in Zurich where we offer Swiss quality and Swiss precision when it comes to timing."

A test of that arrives shortly: SR Technics is tasked with having the last of SAS's refurbished A330s available for service on 15 June, before it starts work on the four A340s in September.

Sattler is fixed on meeting the deadline: "We will never be the cheapest – and we don't want to be the cheapest – but we have to be the best and the most punctual in order to have a value for money that we can offer our clients." ■

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THE PLACE TO BE SEEN

Love it or loathe it, the four-day-long Paris air show remains the biggest event in the industry's biennial calendar, a platform not just to display the latest multi-billion dollar programmes but for an increasingly international supply chain to come together and establish new links across the continents. Twenty years after the internet began to revolutionise the way business is done around the world, the human interaction, the chance to see, smell and touch the product, the sheer serendipity of stumbling upon a great idea, a new contact, an old friend makes global gatherings like Paris irreplaceable. Our special preview package looks in detail at some of the programmes that will be under the spotlight at Le Bourget – some of them there in the flesh, others not – from the CSeries making its first appearance at an air show to what is now becoming a veteran of Paris, the A380, and from icons of the military world like the Dassault Rafale to young pretenders such as the Textron AirLand Scorpion.

CONTENTS

Airbus

Meeting demand for the Neo requires commitment from Airbus's global supply chain, and the investment won't be without risk

RATE OF KNOTS

Airbus is preparing to build 50 narrowbodies a month and is looking to push that higher. Can the supply chain cope and will orderbooks hold out?

MURDO MORRISON TOULOUSE

The law of supply and demand is one of the most fundamental in economics. Record demand for its narrowbodies means Airbus – like its counterpart in Seattle – faces one of the biggest manufacturing challenges in the history of civil aerospace as it ramps up production from a current 42 aircraft a month to an unprecedented 50 by the first quarter of 2017 – and to a possible 60 or even beyond a year or two later, if the most bullish executives in Toulouse get their way.

Getting the supply side of the equation right is crucial. To meet a backlog that currently stands at around 1,350 current-model A320s and some 3,800 of the Neo, Airbus bosses must persuade a global supply chain, which ranges from multinational tier ones such as Pratt & Whitney, CFM International and Safran to family businesses employing fewer than 50 people, to take the risk of investing in new equipment, taking on staff and expanding their factories – and do it quickly.

At the same time, Airbus officials must have in the back of their minds that demand for its aircraft – surely – cannot keep growing exponentially. A catastrophic event – another 9/11 – or even a more rapid-than-expected cyclical downturn sparked by weaker Chinese and other Asian economies could leave Airbus and Boeing – and their suppliers – geared up to produce more narrowbodies than the market wants. Putting the brakes on suddenly could be harder than hitting the accelerator.

Airbus

Airbus is working towards rate 50 on A320

Airbus's top executives, speaking at a briefing in Toulouse in late May, were confident both that the supply chain challenge could be overcome, and that the prospect of an orders bubble, ready to burst, was overstated. With characteristic bombast, chief operating officer - customers John Leahy laid into "consultants from Iowa" (he said he was not referring to any individual) who "don't know what they're talking about" by predicting an imminent collapse in orders.

"If one of these industry consultants says we're going to see a downturn in production," argued Leahy, "ask him what he thinks will happen to global GDP. If he thinks it will keep going up by 2%, then he doesn't know what he's talking about." That level of growth,

suggested Leahy, would be enough to keep orders coming in as fast as Airbus was producing. "All we have to do is keep the backlog level," he said. "We have to make sure the supply chain can do it, but as long as we have a stable supply chain, the market can sustain it."

Airbus is likely to take a decision this year on whether to increase its production rate to 60 a month, although, speaking at the briefing, chief executive Fabrice Brégier noted that it was more likely to be a question of "when rather than if". In the meantime, ramping up to rate 50 remains the biggest challenge for the team led by chief operating officer Tom Williams. And to do that, he must convince suppliers that Airbus is serious about its commitments to increase output.

SUPPLIER RISK

How does he plan to do it? "Transparency. We show them the orderbooks. They know we don't build whitetails," he says. Williams acknowledges that for some "mom and pop" firms, the investment required involves the sort of risk that could topple a business, and he says that to avoid the risk of suppliers themselves being unable or unwilling to deliver on time, Airbus will deploy stick as well as carrot, using more dual sourcing "to sharpen them up".

Williams is also looking at new ways of moving components between Airbus's network of aerostructures plants and final assembly lines. Consignments traditionally carried by the "overstretched" fleet of A300-based Belugas are being moved to road to free up capacity on the outsized transports. In the final assembly line itself, Williams says improved ergonomics are creating an "automotive style flow-line".

With a CFM Leap-1A-powered A320 joining two Pratt & Whitney PW1100G-powered A320neos in flight test in the past few weeks, and assuming a one-year certification effort from first flight in the third quarter of 2014, deliveries will begin in the final quarter of this year. Around that time, production will have begun at Airbus's new final assembly line in Mobile, Alabama, with officials expecting the Hamburg factory to produce half the 50 aircraft a month, Toulouse to handle 17 and the remaining eight to be split equally between Mobile and its Chinese plant in Tianjin.

"As long as John [Leahy] has left the building, and don't tell him I said this, but I think 2018 is when we can reach rate 60 [on the A320neo]," said Williams at the briefing. That would give Airbus just over 18 months at most to add another 10 aircraft a month to an already ambitious output of 50 in 2017. Williams admits there are those within Airbus who might prefer a gentle jog than a sprint to the finishing line, but counters: "Whenever one of my guys complains about the hard work of ramp-up, I ask them if they would prefer to be managing the opposite problem?" ■

FACILITIES **STEPHEN TRIMBLE** RENTON

SAME STORY, DIFFERENT CHALLENGES AT BOEING

BOEING'S FACTORY complex on the south shore of Lake Washington has seen busy times before. In July 1945 alone, the Renton workforce built 160 B-29 bombers, representing about 5.4 million kg (11.9 million lb) of combined empty weight. Seventy years later, an expanded factory with 112,000m^2 (1.2 million ft^2) under roof is again testing the limits of aerospace productivity at a single site.

Only 12 years ago, the same factory produced 737s at a rate of 17 per month, along with about one monthly 757 delivery from an adjacent line. The 757 line was closed two years later, as 737 output rose to an impressive 21 aircraft per month.

That was just the beginning of a decade-long surge of productivity growth. Since 2015, Boeing has doubled 737 output from Renton to 42 aircraft per month. Deliveries will continue to grow to 47 per month in 2017, 52 per month in 2018 and perhaps even higher.

BUILDING EXPECTATIONS

Marty Chamberlin, director of factory operations, recalls "great anxiety over things like 31 per month".

The output growth at the Renton site has coincided with a steady reimagining of how the aircraft are built. A pulsed line was quickly transformed early in the last decade into a moving line. Then the vertical wing assembly tooling jigs were replaced by a horizontal system, with robotic vehicles moving the structures to each station.

Now the focus on driving productivity is in the systems integration area. The Renton facility used to have only two lines, and each line included a dedicated systems integration tool with three positions each. It was here that Boeing's workers installed the hydraulic lines and actuation systems to the fuselage shells that are delivered from the Spirit AeroSystems factory in Wichita, Kansas.

The director of factory operations recalls anxiety over things like 31 aircraft per month

The arrival of the first 737 Max at the final assembly stage later this year will open a third assembly line in the Renton factory. Its presence and the ever-increasing production rates meant Boeing needed to consolidate the systems integration tool into a single complex.

The new structure is three stories tall instead, replacing the two-storey system before. The 737 fuselages are loaded three-abreast into the first station. As each station is completed, the tooling apparatus in front of the fuselage opens like a drawbridge, and the fuselages are moved to a second station.

"Our footprint has been collapsing over the years," Chamberlain says. "So how do we take more advantage of the cubic space?"

Components of the first 737 Max have already entered the production system. The first completed aircraft will be rolled out at the end of this year. First flight of the CFM International Leap-1B-powered aircraft is scheduled in 2016, with delivery in the third quarter of 2017.

The new variant will only make Boeing's rising production rates more challenging, but it also increases Renton's overall capacity. The 737 Max will be assembled on a third assembly line. In theory, all three lines will have the capacity to produce 21 aircraft per month – the limit of the two lines now producing 737NGs. A third line at the same rate raises Boeing's production capacity to 63 737NGs and Maxes after 2018.

In terms of metal, the combined empty weight of 63 737s does not represent even half of the structural mass of 160 B-29s in 1945. But in every other respect, Renton has never been busier. ■

Renton has dealt with surges in production before

Boeing

The CS300's Paris display will come just three months after first flight

Bombardier

LIVING PROOF

The CSeries development troubles were well-documented, but Bombardier is ready to show off the type at Paris – and it has some positive performance results to shout about

STEPHEN TRIMBLE WASHINGTON DC

When the Bombardier CS300 takes to the skies over Le Bourget this year, the 135-seater is not only stealing the spotlight on the aviation industry's biggest stage. The flying display of the most popular CSeries variant also offers a humbled and rebuilt Bombardier executive team a rare opportunity to reset the public perception of the programme.

Of course, none of the programme's well-chronicled troubles – a two-year-plus schedule delay with 40% of the flight test programme still to go; an embarrassing, 100-day grounding last year that spoiled the type's debut at the Farnborough air show and an underwhelming order backlog after eight years on the market – are simply swept away by the double-debut of the CS100 and CS300 in the Paris air show static park.

Bombardier

Bombardier says CSeries capacity is spot on

But the public flying display only three months after the CS300's first flight can highlight some easily over-looked positive facts about the programme's performance so far. By all publicly available accounts, including even one major customer currently threatening to withdraw from the programme, the 18-month-long flight test campaign shows the CS100 is essentially the aircraft Bombardier promised it would be.

The aircraft may be slightly over-weight, according to one customer, but overall its performance is as good as can be hoped: the CS100 can fly the promised 3,000nm (5,560km) segment while reducing specific fuel consumption by 20% and cash operating cost by 15%, as advertised when Bombardier launched the programme in 2008.

Not surprisingly, Bombardier's newly-appointed head of the commercial aircraft division, Fred Cromer, prefers to focus on the performance promises of his predecessors that the CSeries has kept rather than the schedule commitments it has not.

"Given the success we've had in the flight test programme, it's a new level of confidence that we can go out and talk to the marketplace that what we said we were going to do on a piece of paper is what we're going to deliver," says Cromer in a recent interview, "and I can tell you not every new aircraft programme has been actually able to deliver what they've promised early on. But from where we sit right now we feel very comfortable telling you the aircraft is going to deliver what we said it was going to deliver."

OLD-SCHOOL METHODS

Cromer and his even more freshly-hired chief salesman, Colin Bole, strike a different approach than the executives who departed earlier this year. Cromer's immediate predecessor, Mike Arcamone, came to Bombardier only three years ago after a career in automotive manufacturing. One of Arcamone's first moves after being hired in 2012 was to order Bombardier's machinists to build a wooden mock-up of the CS100. It seemed like an anachronism in an era of digital aircraft design, but reflected Arcamone's focus on validating modern tools with old-school methods.

Arcamone's expertise, however, may have been less effective in sales negotiations with airline fleet planners, grasping to understand how to optimise a schedule with aircraft between roughly 110- and 150-seats.

Cromer, by contrast, is an aviation industrial lifer, having served as regional airline

executive, network airline fleet planner and more recently as president of International Lease Finance (ILFC). His new chief salesman, Bole, had worked for Cromer at ILFC before becoming chief commercial officer at lessor Intrepid Aviation. Another former ILFC colleague, now-PlaneView Partners chairman Henri Courpron, has also been brought on board as a strategic adviser.

"I know how to take a schedule and figure out what the best aircraft is for that schedule. So when I sit across the table from the customer I may have a different way of communicating than previous people in this job, because I've been there and I know what they're looking for," Cromer says.

Something needs to change to reset the expectations for the programme. It has always been unfair to compare the CSeries backlog to the nearly 3,800 firm orders claim by the Airbus A320neo and the more than 2,700 Boeing 737 Max aircraft in the backlog through mid-May. Even if Bombardier could sign that many orders, it could not hope to ramp up production to 40 to 50 aircraft a month for several years. But many have still been disappointed by the orderbook of only 243 aircraft on firm order through mid-May.

It seemed even more perilous when the CSeries' third largest customer, Ilyushin Finance (IFC), threatened to withdraw a firm order for 39 aircraft due to new financing problems. IFC chief executive Alexander Rubtsov says the aircraft is performing as expected, but Canadian government sanctions on Russian businesses mean the lessor no longer has access to favourable lending rates from Canada's export agency.

Such risks in the CSeries orderbook have not gone unnoticed by the industry's most influential leaders. When Air Lease founder Steven Udvar-Hazy was asked in March what advice he would offer to Bombardier's CSeries programme, he repeated the same one-word exclamation – "Sell!" – seven times.

Cromer does not disagree with his former leasing industry colleague's guidance.

"I would say Steve is absolutely right," Cromer says. "The emphasis going forward is absolutely going to be additional sales and more customers."

ORDER PROGRESS

The CSeries is making some progress. In early May, Bombardier confirmed that Lufthansa subsidiary Swiss International Air Lines will be the CS100 launch operator, finally removing a perplexing mystery over which customer would receive the first aircraft following certification later this year. Bombardier has also signed a new letter of intent with Malaysian low-cost start-up Flymojo, further highlighting the CSeries' appeal to the low-cost market.

An easy way to generate sales is to offer steep discounts, but Bombardier has always resisted calls to slash prices below a certain threshold. If the CSeries performs as expected, Bombardier has reasoned that it deserves to receive its fair share of the value the product is creating for its customers. The wholesale departure of the company's former commercial aircraft leadership has not changed that position.

"Given the performance of the aircraft now, we can demonstrate that the aircraft is bringing really significant value to airline operators," Bombardier chief executive Alain Bellemare told analysts during a 7 May earnings call. "We want to maximise pricing as much as we can. We [also] want to increase our backlog. There's a fine balance. We don't want to give the aircraft away."

> **"We're comfortable the aircraft is going to deliver what we said it was going to deliver"**
>
> **FRED CROMER**
> Head of commercial aircraft division, Bombardier

Cromer strikes a similar position, suggesting his role is mainly to educate potential customers about the potential value of the aircraft.

"The market sets the price of what the airplane is going to be," he says. "I have some leverage within a certain band to influence that price. And that's … making sure people understand the capability of the airplane, and people should be willing to pay for performance."

But Cromer is also well aware of the fleet planner's immediate response.

"Having been on the other side of it when I'm negotiating these deals, I'd say, 'I don't need that performance so I'm not going to pay for it'. So I understand both sides of the dialogue," says Cromer, who then switches hats to Bombardier executive. "Really the issue is, is there a sizeable market for the capacity that this airplane fills at 100-150 seats? Yes. Is this plane the best airplane optimised for that size capacity? Yes. So, to me, that should make my job easier."

RAMP-UP RATE

Another factor easing the sales pressure on the CSeries sales team is Bombardier's production capacity. Three years ago, Bombardier briefed journalists at its factory in Mirabel, Canada, on plans to ramp up production to 10 aircraft per month within three years of entry into service, with potential capacity to double that rate if demand warranted it.

Bellemare acknowledged in the first quarter earnings call that the three-year timeline may have to be extended.

"We are really trying to understand what is the best ramp-up rate," Bellemare says. We will do the best possible ramp-up. We want to ramp up in cadence as soon as we can, and that's something we are working on with the team right now."

Cromer also hints that the slower pace could be driven by a new focus on improving reliability as the first aircraft enters service early next year.

"We don't want to find ourselves in the position where we are trying to satisfy all of the demand out there and pushing the aircraft through before we're ready," he says. "[That's] because entry into service and operational reliability is almost as or more important than the number of sales we can generate in the backlog. As a former operator I'm equally focused on the entry-into-service performance of the airplane, as I am on selling it and ramping up." ■

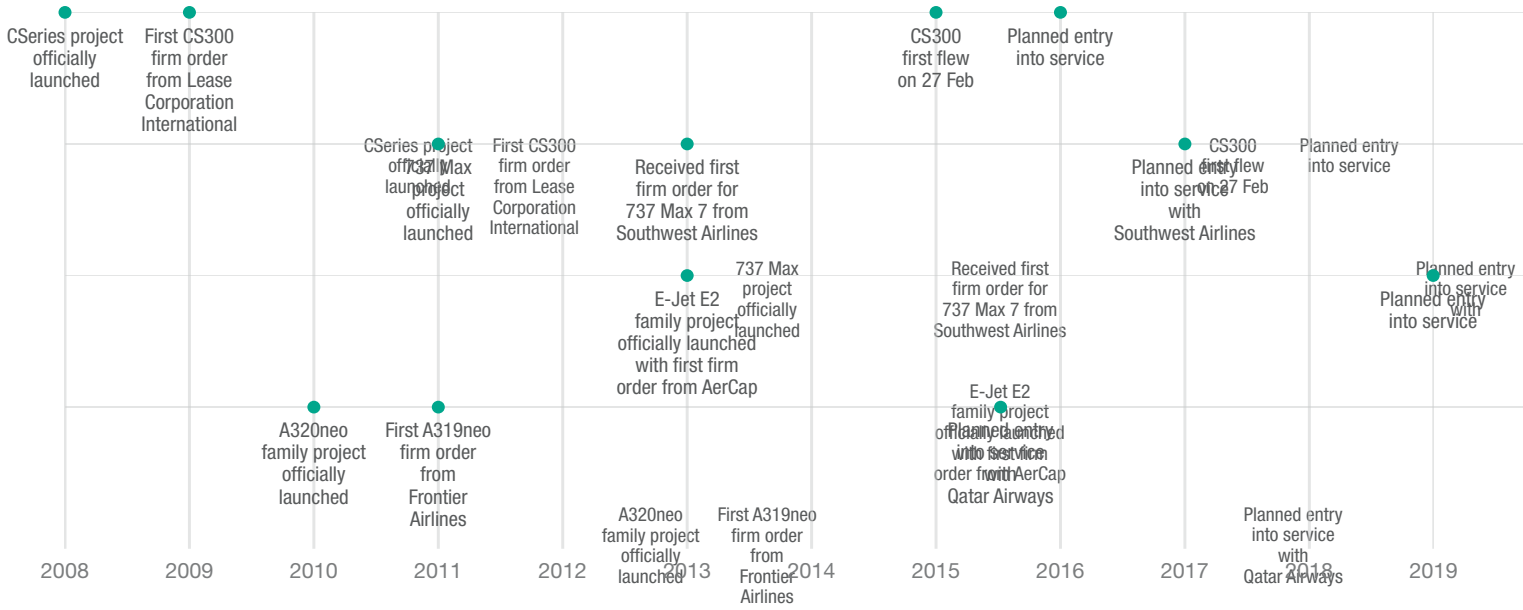
Reports suggest the CS100 is living up to expectations

Bombardier

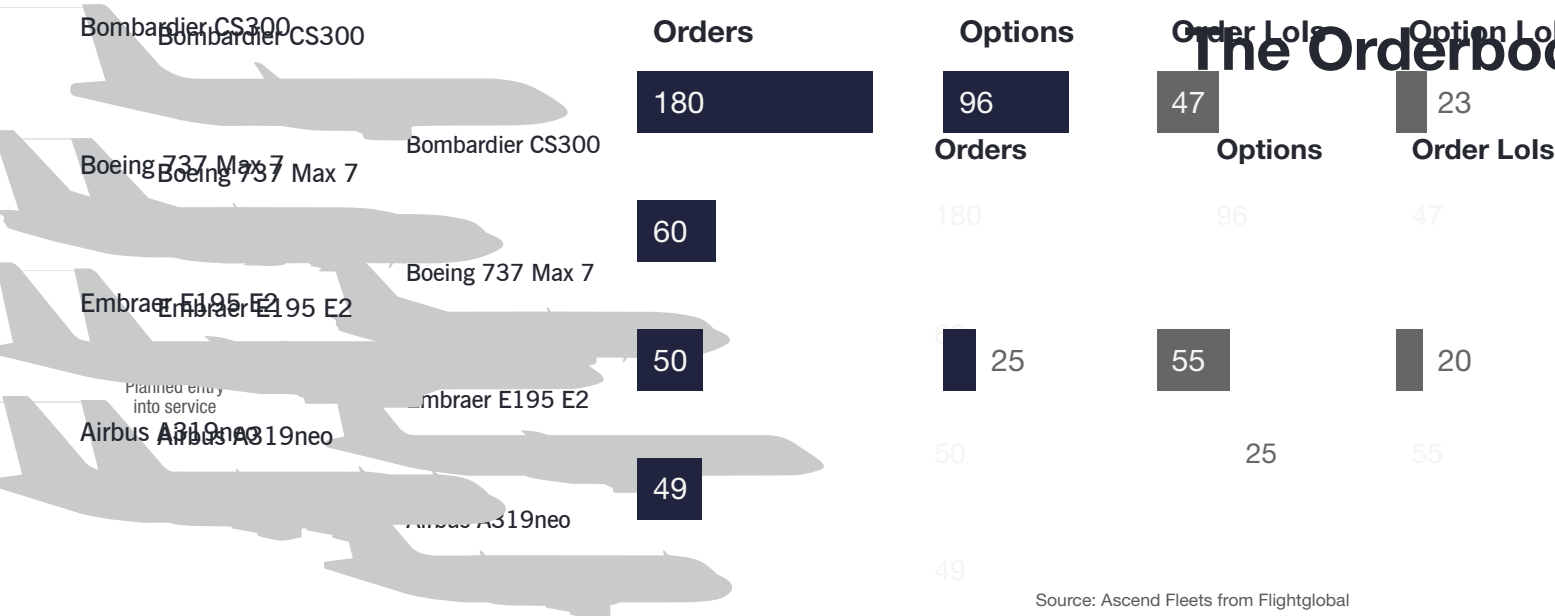
CS300 BY NUMBERS

Despite all the sceptical press coverage, the larger version of the CSeries – which will make its flying debut at Paris – is selling rather well against its closest rivals, as our graphic based on data from Flightglobal's Ascend Fleets makes clear

A Brief History



The Orderbook



Source: Ascend Fleets from Flightglobal

The Orderbook

WHY RUSSIA HAD TO SAVE SUPERJET

A government injection has rescued Sukhoi's regional airliner, but can the Western-backed type compete against constantly evolving competition?

STEPHEN TRIMBLE MOSCOW

SCAC

Russia's Aeroflot operates the Superjet, but SCAC has struggled for orders from outside the region

Sukhoi Civil Aircraft's (SCAC) Superjet programme seemed on the brink of financial calamity entering 2015. A slow-starting production system had already produced a series of annual losses and an overall debt of about $2.5 billion. On top of that, the plummeting value of the Russian rouble only served to increase the cost of the Superjet 100's heavily imported aircraft systems.

By late January, the Fitch ratings agency had lowered SCAC's debt to the top tier of its non-investment grades, but warned that even a "perceived waning" of support by the Russian government for the Superjet programme could sink the company's rating even lower.

It soon became clear that the Superjet's supporters had little to fear. The 86-seat regional jet remains critical to the Russian aviation industry's hopes of regaining a Soviet-era foothold in the global market for commercial aircraft. By late March, President Vladimir Putin had committed to inject 100 billion roubles (about $2 billion) into SCAC, relieving the United Aircraft (UAC) subsidiary of a crippling debt load at a critical moment.

The $2 billion investment "gives us confidence in the future of the programme and gives us additional leverage in financing and developing the programme further", UAC chief executive Yuri Slyusar told *Flight International* in a recent interview.

EASING BURDEN

"First of all, of course, the investment will be channeled to ease the existing credit burden, which is negatively affecting the manufacturing cost," he adds. "Some part will be devoted to potential investment in technical areas."

Fifteen years after Russian design bureau Sukhoi launched development of the small narrowbody, the Superjet is still balanced precariously between programme failure and success story in a perennially unpredictable market segment.

Flightglobal's Ascend Fleets database lists 66 aircraft delivered four years after entry into service, with firm orders for 115 remaining in the backlog, plus options to purchase another 15 and signed letters of intent to buy a further 77. Operators include Russian flag-carrier Aeroflot.

By comparison, Embraer launched development of the E-Jet family only a year before Sukhoi started on the Superjet, but has produced four variants and delivered more than 1,110 aircraft over roughly the same period.

That disparity in sales comes in spite of several advanced technologies embedded in the Superjet 100 design. In a different era of industrial and political co-operation, Boeing consulted with Sukhoi on the design of the Superjet. Alenia Aermacchi, meanwhile, contributed its own certification expertise and »

Superjet International

Mexico's Interjet was the first 'Western' Superjet customer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Alexey Petrov

Four years after entry into service, 66 Superjets have been delivered, with 115 in the firm backlog

Alexey Petrov

SCAC is looking at stretching or shrinking the basic configuration

» relationships with the European Aviation Safety Agency and the US Federal Aviation Administration, along with a majority stake in the Superjet International joint venture tasked with marketing the aircraft beyond the Russian and Asian markets. So far, its only operator is Mexican airline Interjet.

WESTERN INFLUENCE

The Superjet 100 emerged from that collaboration with a host of Western technology, including a fly-by-wire flight control system designed by Liebherr, Thales integrated avionics and a high-pressure-ratio engine core from Snecma.

From a marketing standpoint, what the Superjet 100 still lacks is a family of larger and smaller aircraft. Embraer offers four versions of the current E-Jet and Bombardier has three options between 70 and 100 seats. SCAC still offers only one option with 86 seats in a standard, two-class configuration.

Now that the Russian government has eased SCAC's debt burden, revisiting proposals to expand the Superjet product portfolio are high on the agenda.

"We are currently thinking in two major directions of this family development," Slyusar says. "First is shrinking or extending passenger capacity from 75 to 130. The second major direction is technical improvement in numerous ways. Basically, we had to have some time after the basic model entered the market to evaluate what is most needed, and then to slowly adapt this basic model to improve it."

The market for the Superjet 100 is not static. It was developed in the same class of technology as the Bombardier CRJ700/900/1000 and E-Jet family. In three years, Embraer plans to deliver the second-generation E190-E2 with a more efficient wing and the Pratt & Whitney PW1900G geared turbofan engine. It could make SuperJet International's task much more difficult to expand the market for its aircraft in the West.

So far, UAC has discussed plans to introduce winglets and reduce the weight of the Superjet 100, but the possible launch of a 130-seat version offers an opportunity to make more dramatic improvements.

The focus of any major upgrade would have to include the engine. The Superjet 100 is equipped with the PowerJet SaM-146. It features a low-pressure section contributed by NPO Saturn, a subsidiary of United Engines (UEC), and a high-pressure section developed by Safran's Snecma. The high-pressure module was derived from Snecma's Dem21 demonstrator core, and features a six-stage high-pressure compressor and a single turbine stage.

> **"The second major direction is technical improvement in numerous ways"**
>
> **YURI SLYUSAR**
> UAC chief executive

UAC delivered basic performance parameters for a potential 130-seater to its engine supplier a year ago.

"Together jointly with Snecma we made a preliminary investigation of what it would take to modernise the SaM-146, and so it is possible to make an engine based on SaM-146 for this aircraft,' says Vladislav Masalov, UEC chief executive, in a recent interview.

UAC's requirements for the 130-seat aircraft are not fixed, so the PowerJet consortium developed two options. The first is a "light" upgrade programme involving an improved version of Snecma's full authority digital engine control system and a 3% thrust increase. A larger modernisation is also proposed that includes upgrading the engine core and low-pressure section, Masalov says.

If more fuel efficiency is required for the Superjet 100 to compete on an even basis with a new class of regional jets powered by geared turbofans, Masalov says, UEC can provide another option.

Another UEC subsidiary, Aviadvigatel, is developing the high-bypass PD-14 engine as a Russian-designed alternative to the P&W geared turbofan for the Irkut MC-21, a narrow-body in the same class as the Boeing 737-800 and Airbus A320.

"We can use ideas from the PD-14 engine and incorporate it into an engine of this lower thrust class," Masalov says, "and it will give you a boost of efficiency." ■

SCAC

SCAC's single Superjet option offers 86 seats

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FILLING THE GAP

Customers are making positive noises about a new mid-range aircraft by Boeing to fill an untapped capability space, but performance demands in particular present challenges

STEPHEN TRIMBLE SEATTLE

What kind of aircraft should occupy the yawning gap in size and capability between a 3,600nm (6,670km)-range, 180-seat 737 Max 9 and a 7,850nm-range, 242-seat Boeing 787-8?

That is the question Boeing has been asking internally and among a group of about 30 customers for about three years.

The answer is likely to become Boeing's next major product launch and potentially most technologically ambitious project since unveiling the composite, more-electric aircraft that became the 787 in 2003.

Another decade could pass before such an aircraft – defined within Boeing as the "middle of the market", or MOM, concept – enters service. But a group of customers have "coalesced" on a set of broad performance requirements for the new aircraft.

"What we've heard back from the customers pretty consistently is, yeah, there's certainly some interest in an airplane that is slightly larger and can fly slightly farther," says John Wojick, senior vice-president of global sales and marketing. "But the most important thing they say is it's really got to have economics like the 737 Max, so single aisle-type economics."

Although the new concept is often called a replacement for the 200-seat, 4,100nm-range 757-200, it is clear that Boeing is looking beyond the 757 size and capability as a starting point for the design. The 757 was designed largely to serve domestic routes in the USA, but has evolved to serve a niche role in long-range, transatlantic service.

Airbus claims a long-range version of the A321neo can replace the 757 on those routes, but Boeing continues to reject the idea that either the 737 Max 9 or A321neo has the capacity to achieve true transatlantic range.

Even if the A321neo can match the 757's range, Boeing vice-president of marketing Randy Tinseth counters that the 757 is still inadequate for the task, citing his annual visit to a conference in Dublin, Ireland, which usually requires a round-trip journey on the long-range single-aisle.

RANGE MATTERS

"If you fly from the US, if it's a challenging winter, you arrive about one and a half hours early and on the way home you stop in Nova Scotia," Tinseth says. "So I don't think we should be surprised that they are asking for an airplane with more range."

The MOM aircraft concept should instead carry about 20% more passengers than a 757-200, or up to 240 seats, Wojick says, adding it also should fly about 20% farther than the 757-200 with a full load, so roughly 5,000nm.

Among the options Boeing has considered is shortening the smallest version of the 787


Boeing is likely to leverage mature technologies such as those in the 787-9 for a future aircraft

Boeing

or stretching the longest version of the 737 Max. Speaking to investors in May 2014, Boeing chairman and chief executive Jim McNerney appeared to endorse taking that approach, saying the aircraft will be based on the "mature technologies we've got".

A year later, the trade space still remains open to clean-sheet aircraft designs.

"One of the solutions is to just make the 737 Max longer, bigger," Wojick says. "I'm not so sure that that's the one that's going to be best solution in this market space. A 767-type fuselage is another way to go."

A new aircraft designed to fly stage lengths up to 5,000nm requires a more spacious cabin than available in a narrowbody such as a 757. So the 3.76m (12.3ft) diameter of the 737 Max or even the 3.95m diameter of the Airbus A320neo might not be enough either.

The combination of seat-count and range places the aircraft in a category of the market usually reserved for a widebody aircraft, such as the 5.03m fuselage diameter of the 767.

But there could also be options in between traditional narrowbody- and widebody-sized fuselage cross-sections. In 1985, for example, Boeing launched development of the 7J7 to replace the 737 Classic family of aircraft, but cancelled the project four years later.

The 7J7 concept, however, featured a 4.17m-diameter fuselage. That was not quite wide enough to seat passengers six-abreast in a twin-aisle format. But it was enough space in a single-aisle layout to allow passengers to pass by the catering cart on the way to the lavatory. It is only 41cm (16in) wider than a 737, but it may offer enough comfort to enable long-range segments with an acceptable level of comfort.

"That's a real challenge for our engineers right now," Wojick says. "How can we deliver single-aisle economics in an airplane maybe with a little more comfort? Because it's going to be flying a little farther than our single-aisle airplanes today, and passengers are demanding a little better if I'm going to be in there for longer."

Setting the dimensions of the fuselage cross-section is only one of Boeing's many challenges in resolving the MOM concept.

McNerney has repeatedly discussed customer demands for more performance in smaller packages at lower cost, and the MOM concept offers a case in point.

REDEFINED CONCEPT

One of Boeing's most influential customers, Air Lease chief executive Steven Udvar-Hazy, has called for the new aircraft to do all the things that Tinseth has described, plus take off and land on a 2,130m (7,000ft)-long runway at an airport such as New York LaGuardia. Such an aircraft could redefine the concept of long, thin routes for a sub-250-seat-class aircraft, connecting LaGuardia to Tel Aviv or Los Angeles International to Tokyo-Narita.

The imperative to maintain 737 Max-like economics with such an aircraft seems daunting. McNerney has already stated a clear preference to avoid "moonshot" technologies for any future aircraft project. Instead, he wants the company's designers to focus on harvesting investments in already mature technologies.

Boeing's widebody portfolio has several technologies that have not yet drifted into aircraft smaller than a 787. The 737 Max, for example, integrates a fly-by-wire spoiler, but the four-axis, fly-by-wire flight controls developed for the 777 and 787 have not flowed into a smaller space. The 787's more-electric architecture caused Boeing many headaches as the aircraft was introduced, but the future MOM aircraft could benefit from more than a decade of operational experience with the 787.

> **"The most important thing they say is it's got to have economics like the 737 Max"**
>
> **JOHN WOJICK**
> Senior vice-president of global sales & marketing, Boeing

The aircraft's structural materials also offer another opportunity for leveraging existing technology gleaned from the 787, and to innovate. The same autoclave-cured carbonfibre material originally developed for the empennage of the 777 was later used to build the entire 787 fuselage and wing. It was reused again on the wing for the 777X, and now is available for the structural materials on the MOM.

Meanwhile, the company is also experimenting with out-of-autoclave composite materials, including a resin-infused composite aft fairing in the 757 ecoDemonstrator. Among transport category types, only the Irkut MC-21 wing and wing box are known to use resin infusion techniques for load-bearing structure. Boeing has patented an out-of-autoclave technique called compression atmospheric pressure resin infusion (CAPRI), but it is not known to have been applied on a certificated aircraft.

It often takes decades for new structural materials to be used in primary, load-bearing structures. Autoclave-cured composites first entered service on Boeing aircraft with the non-load-bearing ailerons and doors of the 767, then migrated to primary structures on the 777. A similar growth path could be available for resin-infused composites, which could dramatically reduce production costs and complexity.

Boeing

Boeing is experimenting with a resin-infused composite aft fairing in the 757 ecoDemonstrator

Boeing

Where to build a new aircraft would be a big question as sites such as Everett are full

» "As new material systems come on board, we'll do what we've always done. The empennage of the 777 is made out of the same composite material the 787 is made out of. We started small and grew it in time and in scale," says Scott Fancher, vice-president and general manager of airplane development.

Fancher generally resists requests to clarify the line that separates a smart innovation for a new product and the kind of expensive "moonshot" idea that McNerney deplores. But the overall concept seems rather simple.

"If it's going to create value in the marketplace and it's going to create value for Boeing, it's a worthy investment," Fancher says. "Then we'll flow that into a 'middle of the market' airplane. Does that mean MOM is composite or a geared fan? We'll find out."

ENGINE DEVELOPMENT

Selecting an engine for such an aircraft raises other problems. The 757 is powered by engines in a class between 36,000lb (160kN)-thrust to more than 43,000lb-thrust. By contrast, the highest thrust setting for the two most modern narrowbody engines in development today – CFM International's Leap-1 and Pratt & Whitney's PW1000G – is 35,000lb-thrust. The lowest thrust setting for the available widebody engines – the GE Aviation GEnx and Rolls-Royce's Trent 1000 – is 64,000lb-thrust. So all three engine companies would be tasked with developing a major new derivative or a new centreline engine to power a future MOM aircraft.

For P&W, the challenge is not only about summoning the resources required to design, test and certificate another new commercial aircraft engine. The thrust class needed for Boeing's new project also falls on a possible inflection point for the interior architecture of the fan drive gear system.

The reduction gear in the PW1000G slows the rotation of the inlet fan in relation to the low-pressure turbine at a ratio of 3:1, allowing each module to rotate at optimum speed. As the fan blades turn slower, their length can be increased without causing the tips to rotate faster than the speed of sound. That allows P&W to raise the bypass ratio to 12:1 in the PW1000G, or more than twice the bypass ratio of the International Aero Engines V2500.

> **"Does that mean MOM is composite or a geared fan? We'll find out"**
>
> **SCOTT FANCHER**
> VP & general manager of airplane development, Boeing

But the PW1000G reduction gear uses an arrangement of a sun gear surrounded by five captive star gears, with each star gear encased by a ring gear that drives the fan. As the thrust class of the engine increases with potentially even higher bypass and overall pressure ratios, P&W may have to replace the five star gears with planetary gears.

"If you want to change the bypass ratio and go with a larger bypass ratio but a higher overall pressure ratio then you're going to have to start looking at changes to gear ratio," says Graham Webb, chief engineer for P&W commercial engines. "I think it's about 3.5:1, 3.4:1; you've got this inflection point where you've got to go from star to planetary."

PLANETARY ALIGNMENT

P&W has accumulated more than 15,000h and 30,000 cycles of testing on the star gear arrangement, but the company is also very familiar with planetary gear systems. Pratt & Whitney Canada installs planetary gears in every PT6A turboprop engine, for example.

"There are some technologies we'd like to go and work out, such as oil transfer bearings," Webb says. "It's basically minor evolutionary adaptations of the existing systems."

For Boeing, another decision looms on where to build a new aircraft. The manufacturing home of the 757 is in Renton, Washington, but the site appears fully occupied with three assembly lines for the 737 well into the future. Boeing's widebody manufacturing home in Everett, Washington also appears fully occupied, as new facilities are being built to accommodate growing 787 production rates and the addition of the composite wing for the 777X. The only site with extra room is in North Charleston, South Carolina, where Boeing currently assembles only the 787. But Boeing has more options as well. In a March interview, Udvar-Hazy cited states such as Utah, Kentucky, North Carolina and Alabama as eager to offer attractive deals to a manufacturer such as Boeing, but he acknowledges the decision could create friction with the company's unions.

"That's another issue they've got to deal with – the human side of it," Udvar-Hazy says.

Boeing delivered 1,049 757 aircraft and 249 767-200/200ER models while each was in production. Neither family offered the performance characteristics that it is considering for the MOM concept. It is all-new territory in an industry with few untapped markets remaining. ■

Rex Features

The 4,100nm-range 757-200 flies around 200 passengers

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The 787 is leaving its 'teething' phase, according to Boeing, as the airframer looks towards the launch of the -10, which was announced at Paris 2013

CRUISE CONTROL

Despite all its troubles before and after certification, the 787 has continued to sell well. Boeing's next challenge is to get to production break-even as quickly as possible

STEPHEN TRIMBLE SEATTLE

A familiar and at times unsettling rhythm of crisis management has gripped the 787 programme since it entered production. A major issue – say, a fastener shortage, a side-of-body redesign, a systems reliability breakdown, a production bottleneck – emerges, seizes global headlines and then… subsides. The 787 orderbook, meanwhile, might contract slightly, but mostly it continues to grow through the crisis to where it peaks today at over 1,100 aircraft.

Fastener shortages and structural redesigns are now happily in the programme's past. Production bottlenecks seem to be averted and the wave of reliability complaints appears to have ebbed.

While the programme faces no urgent crisis, there is a new problem to confront: cost control.

In the first quarter, Boeing reported that the first 255 787s delivered so far generated deferred losses totalling $30.9 billion, including tooling costs. Two years ago, Boeing had forecast that deferred costs would peak by the end of last year. At the end of the first quarter, Boeing finance chief Greg Smith extended the timeline to the end of this year.

But now Boeing expects deferred costs to continue rising well into 2016, says Larry Loftis, general manager of the 787 programme.

In a recent interview, Loftis predicted that deferred costs would not begin to decline until after Boeing raises the production rate to 12 aircraft per month, which is scheduled to happen next year.

"We expect our deferred [costs] to grow at about the same rate as we did in the first quarter for the next two quarters or so," Loftis says. "As we get at the end of the year, we believe we'll start seeing the growth rate start to come down. [It will] still grow a little bit. We expect to see deferred 'peak-out' and start coming down and start getting burned off a little bit after we get to 12 airplanes a month because then you do get the productivity [boost]."

The new timeline means Boeing anticipates adding at least another $2-3 billion in deferred costs to the 787 accounting block of 1,300 aircraft.

SPREADING COSTS

By deferring the costs, Boeing is employing a widely accepted accounting policy for highly capitalised industries. It allows Boeing to record an operating profit on each aircraft delivery even though the unit costs exceed the revenues. Those extra costs are recovered by deliveries of later aircraft, which are expected to cost much less to build. Boeing amortises the current $30 billion deferred cost total over a production run of 1,300 aircraft, including nearly 200 787s that have yet to be ordered.

"As we get out to the follow-on blocks toward the end of the decade you start seeing much more favourable performance from productivity gains," Loftis says.

Boeing must "burn down" the deferred cost total before the 787 programme can be truly profitable. Failing to do so could require the company to report a forward loss on the programme, but Loftis is confident that will never be necessary.

"I don't expect to report a forward loss, by no means," he says.

If the 787's track record continues, the deferred production costs challenge will eventually join the long list of challenges already overcome.

It was only two years ago that the global 787 was returning to service following a four-month grounding. Boeing had solved the flawed battery installation that led to the grounding but still confronted widespread reliability glitches. These so-called teething issues stretched beyond the normal period for a newly introduced suite of technologies.

But Boeing officials believe the bulk of the reliability problems are behind them, and the teething phase of the 787 programme's history will soon pass into memory.

DISPATCH THRESHOLD

"We still have a lot of fixes and enhancements that we have in the pipeline," Loftis says. By the end of the year, he adds, the programme will finally transition to a "normal, sustaining-type mode" for servicing the fleet. The crucial measure of aircraft reliability – fleet dispatch rate – is creeping towards 90%, with about half of fleet operators already above that threshold.

The reliability has been steadily improving while production operations have stabilised, Loftis says. Although production costs remain high, most of the bottlenecks have been stamped out. The latest problem to pop out of the supply chain – late shipments of premium seating by Zodiac Aerospace – should be fully resolved by the end of the second quarter.

Otherwise, the stability on the assembly line has kept Boeing's plan to raise monthly output of 787s by 20% next year on track, Loftis says.

"We're on track, and I feel very good about achieving the 12 airplanes per month on our schedule," he says.

The transition to the 12-per-month rate involves more orchestration than may be obvious. Three assembly lines now account for all 10 monthly deliveries, including four from the main line in Everett, Washington, three from an adjacent "temporary surge line" and the last three from Charleston, South Carolina. As it raises the production rate, the company is also closing the surge line and increasing the main line in Everett to a rate of seven per month, Loftis says. Meanwhile, the assembly line at Charleston will increase output to five aircraft per month, but will initially build aircraft even faster as the main line in Everett catches up.

The Charleston factory is "going to build four or five airplanes that they weren't planning a year ago or two years ago", he says.

The next step is to raise the production rate again to 14 per month by the end of the decade. Boeing is already producing 787s at a faster rate than any widebody in the company's history. Achieving the 12-per-month rate required relatively little capital investment, as the company and the supply chain mainly relied on increasing flow times through existing tools and facilities, Loftis says. The next increase in rate also will drive more productivity improvements, but Rate 14 "will require more capital", Loftis says.

"We look at what we call operational equipment efficiency. Simply put, if you have 24h, how many hours of the day is it actually producing?" says Loftis. "Let's say 85% of the time you're producing, you don't want to go much past that because you don't have surge capability if something happens. If you're already at 85%, then you might need to go buy another machine. In some places, we have the capacity in place because we knew these rates were coming and we're learning more and more. In other places, we didn't have equipment and we put those in." ■

Boeing says production of the 787 is scheduled to increase to 12 aircraft per month in 2016

VARIANTS

THE "YEAR OF THE 787-10" COULD BE A QUIET ONE

WHEN BOEING vice-president of marketing Randy Tinseth used the phrase "year of the 787-10" to describe 2015 at the ISTAT conference in March, he appeared to herald a new wave of imminent orders for the largest of the three 787 variants.

But that is not what Boeing's sales team is expecting.

"Some of it won't be acknowledged," says Boeing's chief salesman, John Wojick – or at least, not immediately. "If people have 787s on order, they know they can move from -8s to -9s to -10s. The lead time is well away from when these guys really have to decide which size 787 they want to have. They can make that decision a few years ahead of time rather than six to seven years ahead of time."

Two years after launching the 320-seat-class, 7,100nm (13,200km)-range derivative at the last Paris air show, the 787-10 backlog now stands at 142 firm orders. The programme started in 2013 with commitments by five customers for 102 aircraft. It added a firm order from Etihad a few months later at the Dubai air show. In March, All Nippon Airways added orders for three 787-10s to a 49-aircraft fleet of the smaller variants.

> **"If people have 787s on order, they know they can move from -8s to -9s to -10s"**
>
> **JOHN WOJICK**
> Senior vice-president, global sales & marketing, Boeing

The business case for the 787-10 remains the same. For airlines willing to trade about 1,300nm of range for about 30 more seats, the 787-10 may be an attractive alternative to the Airbus A350-900 or re-engined A330-900, Wojick says. The aircraft's $300 million list price could also help Boeing's efforts to boost margins on the 787 assembly line, with the 787-9 and 787-10 sharing 95% of the same part numbers.

The programme remains on track for first delivery in 2018, arriving shortly after the first 737-8 Max and two years before the 777-9X.

"This airplane is unmatched in terms of its economics," Tinseth says. "I think we'll have some opportunities this year and next year. Our challenge there of course is availability." ■

KEEP ON RUNNING

The 767 has enjoyed a lengthy period of serial production. Even so, Boeing has surprised many with a bullish assessment of the type's commercial future

Well over 1,000 767s have been delivered

Boeing

STEPHEN TRIMBLE SEATTLE

By any reasonable standard, Boeing's 767 has had a good run. The twin-engined widebody is approaching 35 years of uninterrupted serial production. It has outsold its smaller, narrowbody sibling, the 757, with 1,073 deliveries up to April 2015 and orders for 38 commercial freighters left in the backlog.

But something unexpected is happening inside the 40-32 and 40-33 bays of Boeing's final assembly complex in Everett, Washington.

One year after Airbus launched the re-engined version of the A330, which appeared to kill any last hope for the passenger-carrying version of the 767, Boeing is revitalising the twinjet's production system. It is true that the US Air Force plans to buy 179 KC-46 Pegasus tankers based on the 767-2C platform, but several of the production system changes – including a previously undisclosed performance improvement upgrade for the engine – are reserved for the commercial variant.

"We think it's a viable programme for decades to come," says Brad Zaback, Boeing's vice-president and general manager for the 767 programme.

Zaback is not speaking just about the USAF's tanker programme, which is scheduled to run through to fiscal year 2027.

Boeing

The 767 has been in production 35 years

The commercial freighter market is also in Boeing's long-term sales strategy for the 767. So far, the company has revealed no plans to launch a freighter version of the 787, the composite-skinned twin-jet that entered service in 2011 to replace the passenger-carrying 767.

LONG WAIT

Moreover, Boeing's middle-of-the-market concept – now sized somewhere between a 757-300 and 767-200 – could be nearly a decade away from entry-into-service for the passenger model. The freighter version may not appear for several more years beyond that.

So, for the foreseeable future, the 767 remains Boeing's premier offering in the medium-sized freighter market, where it competes with the much larger Airbus A330-300F and conversions of older A300-600s and 767s.

"There's not a lot of choice [in that area of the market]," Zaback says. "[For the future,]

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"We think it's a viable programme for decades to come"

BRAD ZABACK
Vice-president and general manager for 767, Boeing

» we have our 'middle of the market' studies. That will take care of that kind of market. Until then, we still have the [767]."

Deliveries of 767s slowed to a crawl last year as Boeing focused on building the first four 767-2Cs to support the flight test plan for the KC-46 tanker programme. Boeing delivered the last passenger-carrying 767-300ER in the order backlog last July to Air Astana, and FedEx received five 767-300Fs, making a total of six aircraft deliveries.

Boeing has already matched that output in the first four months of 2015, as the production rate was increased last December from one aircraft every two months to 1.5 per month. Deliveries will rise to two per month in 2016.

The rising deliveries partly reflect the USAF's acquisition plans. The latest plan, released in February, expects orders to rise from seven this year to 16 in FY2016. The annual orders will peak at 18 in FY2017 before slowing to 15 two years later. Planned annual orders average 13.25 in the remainder of the programme through to FY2027.

WANTING MORE

That plan gives Boeing capacity to deliver six to nine commercial freighters per year, assuming a steady production rate of two aircraft per month. But the company is sizing the production system to deliver even more aircraft. A new automated drilling and fastening machine for the 767's wing panels is capable of completing one unit every eight working days, which equates to a monthly production rate of 2.5 units.

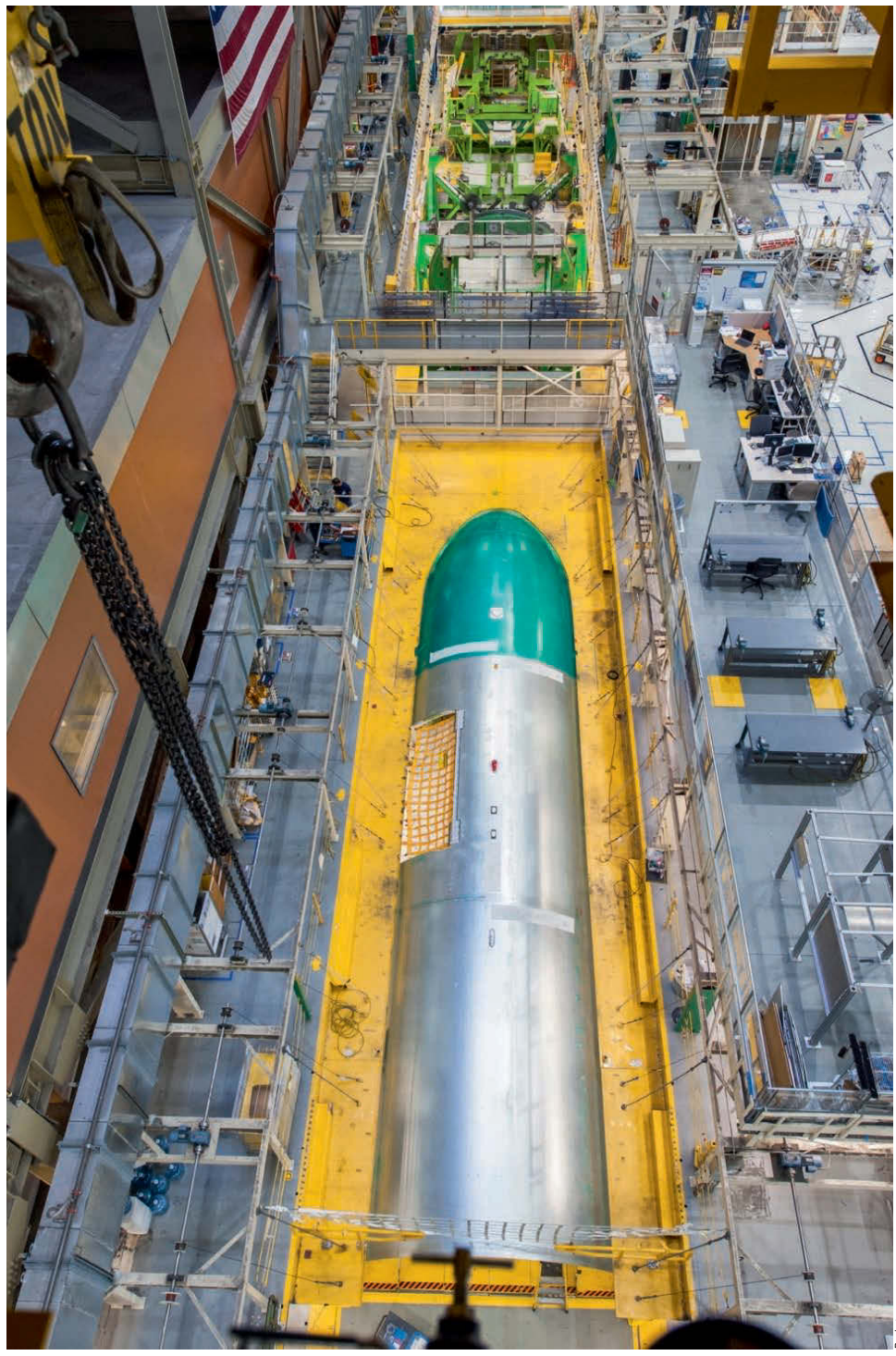
The new automation replaces drilling systems that entered the 767 production system about 30 years ago.

Boeing also is automating the drilling and fastening work at the critical fuselage join positions, leveraging Flex-Track technology already in use on the 777 and 747 production lines, Zaback says. The way the joins are fastened and spliced is also being improved, he says, to reduce the number of fuselage panels that must be scrapped due to assembly errors.

The performance of the 767 is also still being tweaked – nearly 33 years after the type entered service – even though its ostensible replacement has already arrived. GE Aviation quietly developed a performance-improvement package for the CF6-80C2 engine with a 0.5% improvement in specific fuel consumption. The KC-46 is powered exclusively by the Pratt & Whitney PW4062, so the engine improvement is reserved for the commercial freighter market.

FedEx is, so far, the only beneficiary of the 767 assembly and performance upgrades. It continues to reinvest in the 767, placing four more orders last October and adding an order for another aircraft earlier this year.

"The more competitive and the better product we can deliver," says Zaback, "[the more] the market is going to be there." ■



Boeing

Last year was a slow one for the 767, but deliveries will rise to two per month in 2016

Boeing

The 767 freighter remains a strong contender

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DOUBLE DILEMMA

The lack of recent orders and uncertainty over viability of an A380neo give Airbus plenty to think about as it tries to plot a future path for the world's largest airliner

Airbus

British Airways has kept to a modest order for 12 A380s, despite its position as the biggest 747-400 customer, showing the challenge faced by Airbus

MURDO MORRISON TOULOUSE

Ten years after the A380's quietly impressive airborne choreography wowed the crowds at its Le Bourget debut, Airbus continues to insist that a commercial breakthrough for the world's largest airliner is on the horizon, even if it now concedes its flagship is not going to transform long-haul flying in the way the world's first jumbo jet, the Boeing 747, did in the 1980s. However, with airlines and passengers having had plenty of time to get used to the ultra-large airliner and no orders for the type for many months, even Airbus's modest targets could be ambitious.

Although A380 operators number blue-chip carriers such as Air France, Singapore Airlines, Qatar Airways and Qantas, only one airline has put the superjumbo at the core of its route strategy. With 60 in its fleet and 80 on order, Emirates represents 45% of the A380's total orderbook and half its backlog. Therein lies Airbus's problem. The Dubai airline wants Airbus to develop a new generation A380. But with the programme only edging into breakeven on a unit basis this year, even Toulouse's most bullish salesmen are unconvinced about launching an A380neo for one customer.

Another looming concern for Airbus – although its executives were presenting it as an opportunity at a pre-Paris briefing in Toulouse in late May – are the A380s that will start to filter onto the secondhand market when Emirates and other early customers begin to replace 10-year-old examples. With demand for new A380s soft, and lessors still to find customers, even a modest number arriving on the market is likely to depress residual values, warns Rob Morris, head of consultancy for Flightglobal's Ascend advisory arm.

> **"It is very difficult to see a secondary market for a 500-seat aircraft"**
>
> **RICHARD EVANS**
> Senior consultant, Flightglobal's Ascend consultancy

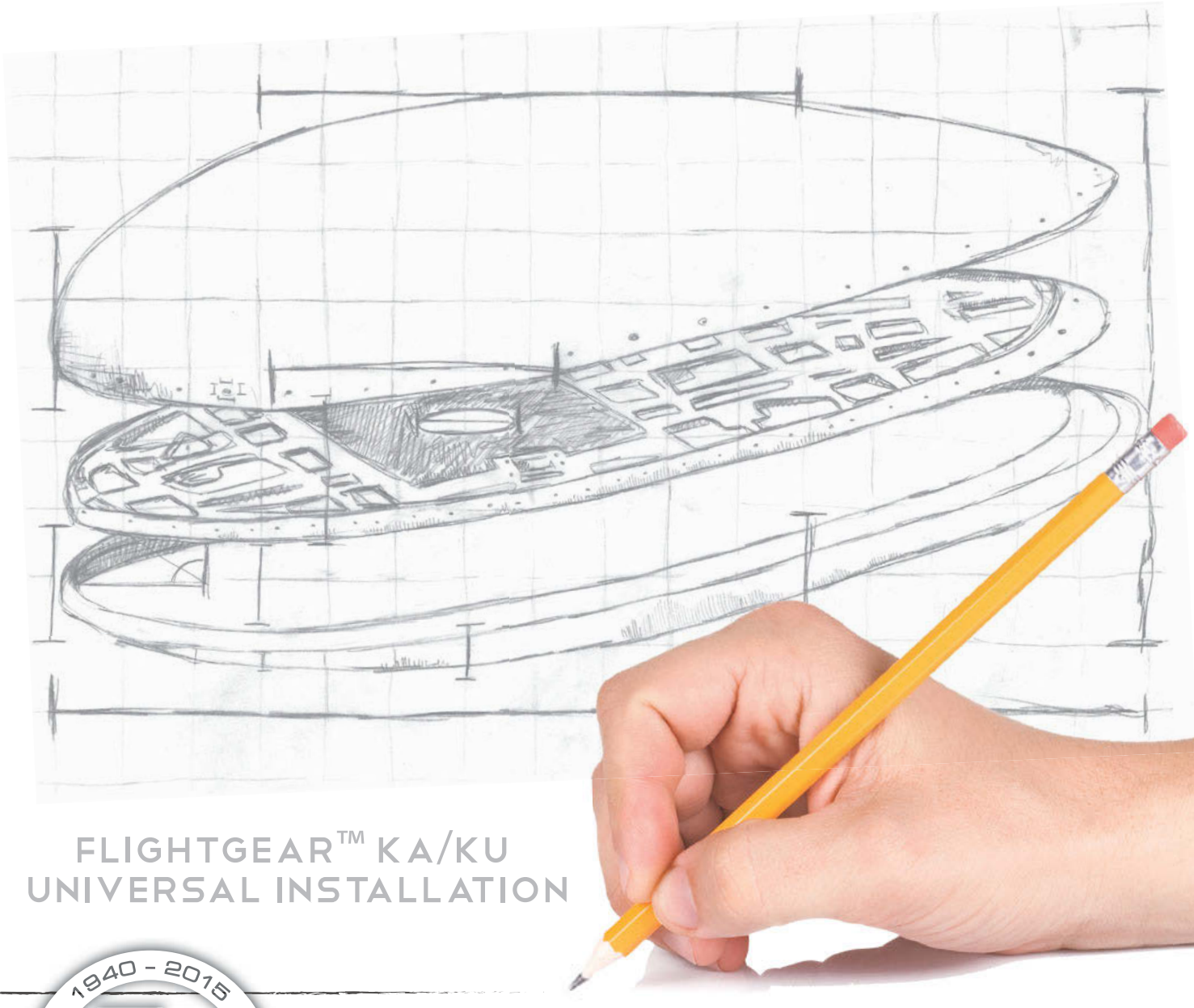
Airbus's top salesman John Leahy hints at more A380 sales this year. However, with several of the key operators of 747-400s seemingly uninterested in the double-deck airliner (or its Boeing rival, the 747-8I, for that matter), and the biggest 747-400 customer, British Airways, happy to stick with its modest commitment for 12, it is difficult to see where demand for an ultra-large transport is going to come from. This is despite projected rising numbers of what Airbus calls mega-cities – whose airports serve more than 10,000 long-haul passengers a day – from 42 to 91 – by 2033.

POWER PLAY

Emirates' move to switch A380 engine-provider from Engine Alliance to Rolls-Royce has also it seems quashed any early Airbus decision on an A380neo. Emirates' boss Sir Tim Clark had originally said 25 of the 50 aircraft ordered at the 2013 Dubai air show – due for delivery after 2020 – were earmarked as Neos, with the prospect of further orders of a re-engined A380. The announcement that all 50 will now be Trent 900-powered looks to have punctured immediate prospects of a Neo, although Clark still offers the prospect of equipping later deliveries with a new version of the Trent.

Rolls-Royce's chief operating officer for large civil engines, Simon Burr, says that, for its part, the engine maker is prepared to work with Airbus on plans for a Neo. "We're aware of discussions and we will be there with them," he says. In some ways, it is the UK company – as the most likely source of an exclusive engine for an A380neo – that would carry most of the cost of any development. While the new aircraft would likely incorporate additions such as sharklets and an aerodynamic "clean-up" to achieve a mooted 10%

REIMAGINING CONNECTIVITY



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» efficiency improvement, R-R would bear most of the risk.

However, analysts such as Richard Aboulafia of Teal Group remain sceptical Airbus leaders will agree to a re-engining. Even with the prospect of additional orders from Emirates, the programme – from its early production crisis that forced Airbus to restructure its entire business due to its continuing flagging sales – has left deep scars in the Toulouse boardroom, even leading to hints last year that the entire programme may be axed at the end of the decade. "I say it doesn't happen [an A380neo], because I have faith in Airbus," said Aboulafia at a conference earlier this year.

"Focusing on increased cabin segmentation is key to maximising A380 yields"

DIDIER EVRARD
Executive vice-president programmes, Airbus

The prospect of the first used A380s entering the market make the prospect of an A380neo even more unlikely, argues Aboulafia. It is a view backed up by Richard Evans, senior consultant at Ascend. "It is very difficult to see a secondary market for a 500-seat aircraft," he says. "There were a reasonable number of 747-400s transitioned to other passenger airlines, including some major operators, but nobody seems very enthusiastic about A380s. It will be a very expensive aircraft for a second-tier airline to absorb and operate."

MID-HAUL OPPORTUNITY

Airbus executives disagree. Used A380s are a "unique opportunity for operators who have never considered an A380 before," particularly in markets such as Asia, says Leahy. The aircraft could allow airlines flying mid-haul routes to upscale capacity, he says.

The new watchword for Airbus now with the A380 is flexibility. While Etihad's decision to equip its first superjumbos with its enclosed Residence suite – the ultimate VIP cabin, complete with personal butler – hearkens back to early visions of interiors complete with casinos and communal lounges, A380 marketing today is more about higher-density payloads and options to experiment with different passenger offerings. "Focusing on increased cabin segmentation is key to maximising yields on the A380," says Airbus's executive vice-president in charge of programmes, Didier Evrard.

One of Airbus's plans is a combined crew rest area for the A380 that increases seating capacity. By combining the forward flightdeck crew rest area, behind the cockpit, with the aft underfloor cabin crew rest station, the airframer believes it can free sufficient space to install six premium-economy passenger seats. Use of premium-economy seating and 11-abreast layouts are among Airbus's strategies to strengthen the A380's cabin economics, suggesting that a 291-seat Boeing 777 would have a 23% higher per-seat cash operating cost than a 544-seat A380 – with similar comfort levels.


Airbus

An Etihad A380 during final assembly

Last year, after signing for 20 A380s at the Singapore air show, Amedeo chief executive Mark Lapidus said creating higher-density A380s was key to unlocking demand, suggesting Airbus originally mis-sold the superjumbo as a luxury airliner, allowing airlines too much flexibility in determining where galleys and other monuments were positioned, and distracting from its main unique selling point, which was superior seat-cost economics. Amedeo, which will take deliveries of its A380s from late next year through to 2020, has still not announced any customers, however.

SEAT-MILE CONSIDERATION

Emirates, which has pioneered innovations such as on-board showers in its first-class cabins, is also moving towards higher-density operation, with plans to introduce a two-class, 615-seat A380 on services to Copenhagen in December. The Dubai airline initially configured its A380s with 489 seats and subsequently introduced a 517-seat version. Although revenue from premium customers remains crucial for most long-haul airlines, the importance of seat-mile costs in an era of fluctuating fuel prices could be the factor that eventually convinces more airlines of the A380's appeal.

Airbus finished 2014 with just 13 net orders for the A380, and says its priority is securing more sales as a result of incremental improvements to the type. Although last year saw the welcome Amedeo order, there were also cancelled aircraft, including six from bankrupt Japanese carrier Skymark, now the subject of a lawsuit filed by Airbus in Tokyo. This year also brought news that Transaero is in talks to reschedule its four Engine Alliance

Emirates accounts for half of the A380 order backlog

GP7200-powered A380 deliveries with the Russian airline industry in crisis.

Equally worrying for Airbus was British Airways parent IAG's admission that it does not need more A380s, despite operating from one of the most slot-constrained hubs in the world. Airbus's case for the A380 is based on its economics from busy airports and its passenger appeal. IAG chief executive Willie Walsh said this year that the UK carrier's nine 469-seat A380s had had a "very positive" performance from "both a customer and a revenue point of view". Yet, frustratingly for Airbus, he added that there were only a few routes in its network for which the A380 model made sense.

One piece of good news for Airbus is that the programme will hit breakeven this year. That means that every A380 is no longer delivered at a loss. But while that is positive for Airbus Group's profit and loss figures, it is uncertain if the project will ever recoup the billions spent on its development in the 1990s and early 2000s. Airbus still insists the A380 is an idea ahead of its time that will eventually win converts thanks to the compelling logic of its ability to carry more passengers from one busy airport to another than any competitor. Sceptics think its time may have already passed. ■

Additional reporting by David Kaminski-Morrow

Airbus

PRODUCTION **STEPHEN TRIMBLE** WASHINGTON DC

747-8 DEMISE REPORTS COULD PROVE PREMATURE

ANALYSTS WERE writing the obituary for the Boeing 747-8 programme last January. When the US Air Force committed to buying the aircraft for an Air Force One replacement, Boeing was expected to cease production after delivering the two VC-25A replacements to the US government in 2017, concluding a proud, 48-year production run.

But neither the USAF nor Boeing appear willing to play by that script.

Boeing chief executive and chairman Jim McNerney announced in April that the company remains committed to building 747-8 freighters and passenger-carrying variants for years to come, even allowing output to decline to as low as one per month, if necessary.

The USAF also released budget documents in February that propose an unusual funding arrangement for the next Air Force One fleet. Rather than pay for both aircraft upfront, service officials plan to make an initial payment in fiscal year 2016 on the first aircraft and perhaps complete the acquisition of the second aircraft in 2020. So count the USAF among those who believe the 747-8 assembly line will still exist in five years.

Boeing

Boeing aims to maintain 747-8 output for many years

There is some logic to buttress Boeing's optimism in the 747-8's longevity, despite a slim backlog of only about 32 aircraft entering the Paris air show.

The air cargo sector was devastated for two years by the 2008 financial crisis, weakening the market as the 747-8 was mired in development delays. The market appeared to rebound successfully in 2010, but then remained basically stagnant for the next three years. Hundreds of large freighters were parked in storage in desert parking lots, as their owners awaited a recovery.

CARGO RECOVERY

That recovery appears to be happening, although at a slower pace than Boeing may prefer. Global air cargo traffic improved by 4.5% last year and is forecast by IATA to grow at roughly the same pace this year.

"It's a very, very big deal to us that this market is going up again," says Boeing 747 vice-president and general manager Bruce Dickinson.

The recovery may not lead to a new wave of 747-8F orders, however. The fastest growing segment of the air cargo market is carried in the bellies of passenger airliners, such as the 787. Some airlines have selected the 777F to replace older 747-8 Freighters recently. Boeing is keeping its options open by controlling production costs. A third rate cut from the original output of two aircraft per month will take effect in August, with monthly deliveries declining to 1.3. Another rate cut is not out of the question.

"We've made the production system so efficient that there is room" to reduce the rate again, Dickinson says. "One a month would keep it profitable." ■

Boeing

Efficiencies mean a production rate of one aircraft a month would still be profitable

CAN BOEING WING IT ON THE 777X?

The airframer is planning big changes to production systems at Everett as it prepares to handle concurrent components for old and new variants of its large twin

STEPHEN TRIMBLE SEATTLE

This was Boeing's problem: a new version of the 777 with a new engine and a composite wing will enter service in 2020, but the older version with a metallic wing will likely stay in production as a freighter for at least another five years. So how does the company eventually assemble both types down a single bay of the sprawling factory complex in Everett, Washington, while maintaining a brisk, 8.3-aircraft per month production rate?

A very similar problem – albeit involving a much slower pace of production – came up a decade ago as the re-winged and re-engined 747-8 entered production alongside the last 747-400s. Boeing's attempt then to assemble both types in the same factory at the same time ended in failure.

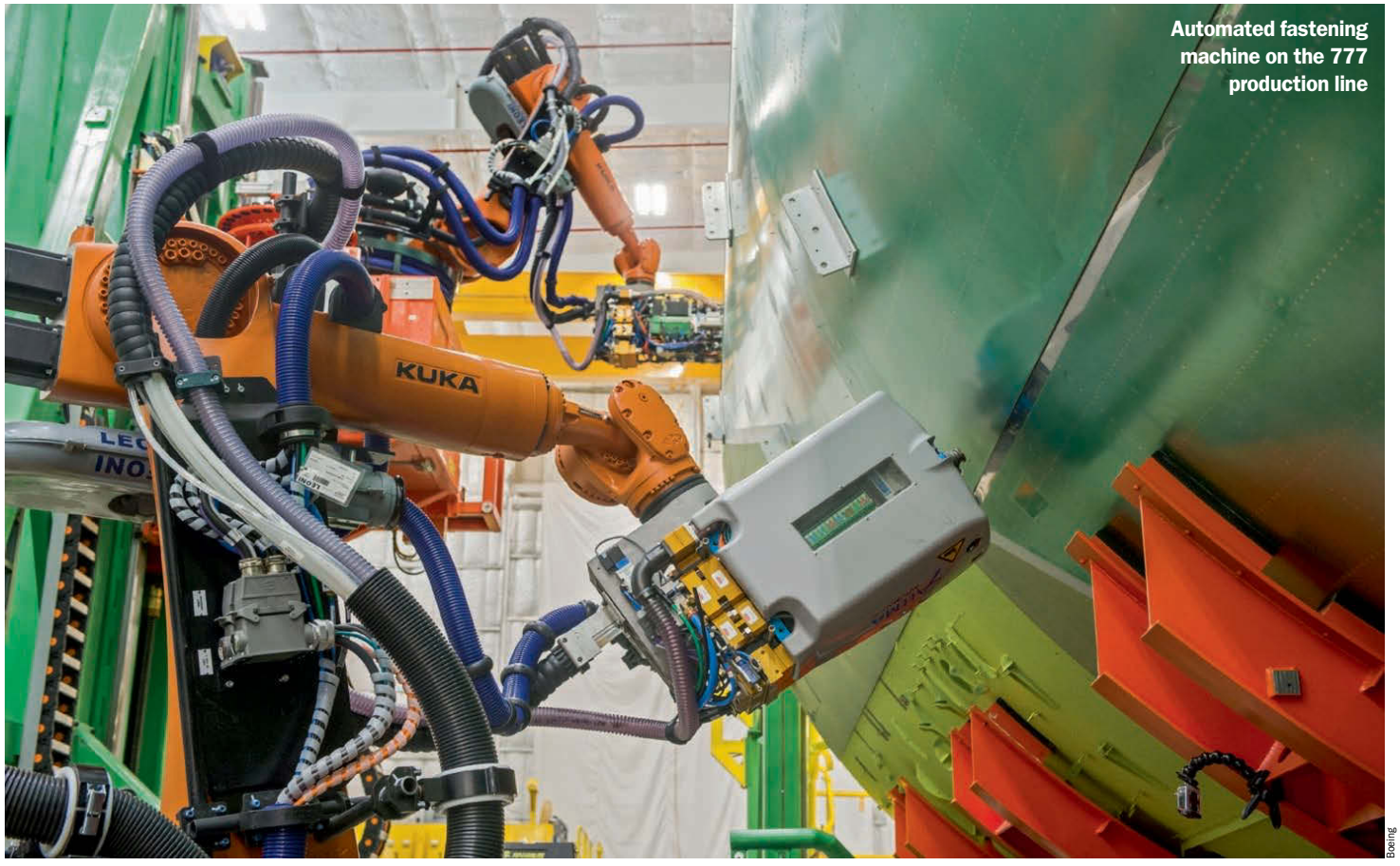
Avoiding a repeat of that awkward chapter is clearly on the mind of the 777 programme's executives. They also face the added pressure of being entrusted with one of Boeing's most successful franchises – and one the company is counting on to seamlessly transition to the improved 777X family over the next five years.

As Boeing celebrates the 20th anniversary of the original 777's entry into service on 7 June, the company has also unveiled a plan to fundamentally redesign the aircraft's production system to accommodate the assembly of newer and larger aircraft types, while not sacrificing quality or output.

TRANSFORMING PROCESSES

"We will really be transforming the production system over the next two to three years to a monument-free environment," says Elizabeth Lund, Boeing's 777 vice-president and general manager.

This new iteration will represent at least the third major evolution of 777 production since the type was introduced two decades ago. The original method had 777s parked in slant positions with large tooling platforms erected around the aircraft during assembly. As production capacity increased from seven to more than eight per month, the slant positions were replaced by a moving line with large tooling systems still required for the wing-to-body join position.



Automated fastening machine on the 777 production line

Boeing

Boeing hopes the transition to the 777X will be smoother than its experience with the introduction of the 747-8

Boeing

Large, immobile tooling jigs will be eliminated in the new factory. Major fuselage sections and wing assemblies will instead be "cradled" in highly automated tools, which will be advanced down the line on automated guide vehicles. Boeing's inspiration is the highly-automated automotive industry.

"It's automation, but it's more than automation," Lund says. "It's also the thought that we will be designing for a more producible airplane, much like in automotive. It means we will be transforming the way we deliver parts and tools. And we will be really streamlining that entire production system so that it really flows."

The key piece in this new model for commercial aircraft manufacturing has already been introduced. The fuselage automated upright build (FAUB) system may not have a catchy name, but it addresses the key issue that has kept aircraft factories in the pre-automated, manual era. Unlike automobiles, aircraft are assembled with fasteners. In the case of the 777, hundreds of thousands of fasteners are required. Each fastener requires a two-person team: a riveter to guide the fastener into a pre-drilled hole and a bucker on the other side to apply pressure and compress the fastener into place.

The major fuselage sections for the 777 measure several metres in length. To automate the riveting and bucking process, Boeing needed to develop a robotic system that can operate in pairs along the length of the fuselage. The FAUB is Boeing's solution for that problem. It partnered with robotic systems expert Kuka, which developed the riveting and bucking equipment. Boeing then refined how they work during a year-long series of testing at a rented facility in Anacortes, a small town along Puget Sound north of Everett.

Kuka "really reduced the learning curve," says Jason Clark, Boeing's vice-president for 777 and 777X manufacturing. "It would have taken us a decade-plus to develop this on our own. It's an extremely important relationship."

A FAUB-manufactured, representative 777X fuselage section is undergoing fatigue tests that will simulate 60,000 cycles, or three times a normal operational life. The results will be available in August, which should allow Boeing to proceed with using the FAUB in regular production beginning later this year, Clark says.

PRODUCTIVITY IMPROVEMENTS

The new automated production systems are expected to dramatically boost production. Boeing estimates that the FAUB will increase productivity by 50% initially, and then improve over time. But company officials are being careful not to disturb the existing manual and automated processes. In fact, Boeing is building a new 350,000ft² (32,500m²) assembly bay – dubbed 40-27 – to introduce automated systems. As the robotic alternative is validated, it is then migrated into the regular 777 assembly bay.

"One of our key tenets is never to risk the production system that we're so proud of," Clark says. "To be able to protect that line, we've created another facility in parallel with the existing production line. That allows us to slowly ramp up on the technology and never put that assembly line at risk."

The Everett facility's single bay posed problems

Boeing

Automation is being applied in another key area for the 777 and 777X programmes. The 777X empennage – a pair of horizontal and one vertical stabiliser – will be about 1.27m (50in) longer than the original 777, but both types will be drilled using the same automated system, eliminating about 58,000 manual drills on each shipset, Clark says.

"When we designed the automated system, we didn't know the 777X would have a bigger horizontal and vertical [surface]," Lund says. "But the [automated] line can accommodate that. You don't have to re-tool. That's kind of the 'a-ha' we're trying to give you. This approach and philosophy can adapt to that."

There are still limits to automated drilling and fastening on the future 777 line. Each of the major structural join positions must continue to be assembled manually.

"But we're working on trade studies right now: how do you automate that part of the assembly," Clark says. "We're still not there."

> **"We will be really streamlining that entire production system so that it really flows"**
>
> **ELIZABETH LUND**
> 777 vice-president and general manager, Boeing

No trade study, however, will overcome one area of the 777 production system that can never be reconciled. The 777X replaces the original metallic wing with a composite structure. Boeing plans to keep producing 777 Freighters for several years after the 777-9X enters service. That means it will maintain separate assembly lines for the metallic 777F wing and the composite 777X wing.

"The wing is a different story. It has its own production line," Clark says. The 777X wing will have a "whole different assembly method with new robotic technology that does that drill and fill on carbonfibre. We'll continue to invest in the aluminium wing line. It is one portion of the lines that will twilight over time as a new [777X] freighter comes into view."

By re-engining and re-winging the 777 rather than replacing the aircraft with a clean-sheet, Boeing gave itself another two decades to improve on a familiar production system. The company is not starting largely from scratch as it did on the new design for the 787. That makes the 777 an easy candidate to automate a set of well-understood tasks for assembling a metallic fuselage, while leveraging the 787 experience on the carbonfibre wing. It also underscores Boeing's commitment to moving beyond manual labour for future assembly work. ■

Qatar Airways began flying the A350-900 earlier this year

Airbus

BACK IN THE RACE

What a difference 12 months can make. The successful introduction into service of the A350-900 and the Farnborough launch of the A330neo have given Airbus a new impetus in a large twin market dominated by Boeing

MURDO MORRISON TOULOUSE

A year ago, as the Farnborough air show approached, Airbus's long-haul strategy looked in disarray. One of the biggest customers for its A350 XWB, Emirates, had suddenly cancelled an order for 50 -900s and 20 -1000s, while the smallest A350 – the 280-seat -800 – had a rapidly diminishing orderbook. Toulouse's decision to take on both Boeing's 787 and 777 with one aircraft family looked ambitious at best – even more so since the launch of the 777X at the end of 2013.

At the same time, the A330 – the best-selling small twin-aisle aircraft ever – appeared to be running out of steam almost three decades after its launch, while its A340 stablemate – designed to appeal to airlines that wanted the range, payload and reassurance that four engines offered – had long-since fallen victim to high fuel prices. Finally, Airbus's flagship A380 was failing to win the Queen of the Skies crown once worn by the 747-400; the elite of the long-haul world, other than Emirates, were either committing in modest numbers or showing little interest.

HEALTHY PROSPECTS

Twelve months on, Toulouse's widebody prospects look much more healthy. Airlines may remain unconvinced about an ultra-large aircraft, but Airbus's next two biggest twin-aisles, the A350-1000 and -900, have continued to sell well, with orders approaching 780 units. Meanwhile, the decision to launch two variants of a re-engined A330 at Farnborough, powered exclusively by Rolls-Royce Trent 7000s, appears to have given momentum to its small widebody, with 145 orders for the re-engined twinjet.

The A350-900 entered service earlier this year with Qatar Airways and, with three aircraft in operation, the type is performing well, says Airbus. This year will see 15 A350 deliveries, including to three new operators – Vietnam Airlines, Finnair and Latam. Early in 2016, the first A350-1000s will move into final production, with first flight of the larger variant in the middle of the year. Production should steady out at rate 10 around 2019, says Didier Evrard, Airbus's executive vice-president and head of programmes.

Although Airbus faces huge manufacturing upheavals, particularly the ramp-up of its narrowbodies, chief executive Fabrice Brégier was speaking only half in jest at a media briefing in Toulouse in May when he described the company these days as "boring". With the exhausting engineering Everests of bringing the A380 and A350 to market climbed, Airbus's widebody priorities include handling two ramp-ups (and a ramp-down), ensuring three new variants, the A350-1000 and A330-900neo and

Delta Air Lines has taken delivery of the first 242t MTOW version of the A330-300

Airbus

"If the best salesman in the world thinks he can keep the A330ceo at rate six, we can"

TOM WILLIAMS
Chief operating officer, Airbus

A330-800neo, enter service smoothly, and, not least, finding new customers.

Not that these are minor challenges. The manufacturing transition from the A330 "current engine option" or "ceo" to the A330neo will be relatively painless as there is much commonality between the variants. However, the Trent 7000 is a much bigger engine, with a larger fan and double the bypass ratio. Other structural changes to the aircraft include Sharklets. As Airbus prepares to introduce the A330-900neo to service at the end of 2017 – with the -800 following a year later – it must also take care to bridge the gap by keeping up production of the current model.

SHRINKING BACKLOG

Output of the A330ceo is dropping to six a month next year, a rate that Airbus will be keen to hold as the backlog shrinks. That will depend on sales success this year, something Airbus's sales chief, John Leahy, hinted at at the briefing in May: "You will see some A330ceo orders announced by the air show," he said. His fellow chief operating officer, Tom Williams, who is in charge of Airbus manufacturing, has faith in his colleague. "We have the best salesman in the world and if John thinks he can sell enough to keep the A330ceo at rate six, I'm confident we can," he says.

New versions of the A330ceo will help. A team from Delta Air Lines arrived in Toulouse during May's media briefing to take delivery of the first 242t maximum take-off weight (MTOW) version of the A330-300. The option, which offers a 2% fuel-burn reduction and an extended range of 6,100nm (11,300km) – by way of a series of design tweaks such as shortened flap track fairings and a reshaped slat one – was launched in 2012 and has been sold to 11 customers.

The opposite approach also saw Airbus launch in 2013 what it calls the A330 Regional, a high-density aircraft tailored for shorter routes through a reduction in its MTOW. Toulouse has already identified Chinese airlines as potential customers and Leahy said Airbus was pursuing "several campaigns", adding: "I expect to have an announcement by the [Paris] air show." Five A330s will be used as the basis for new in-house Beluga XL transports, the first of which will begin to replace the current fleet of A300-600-based cargo aircraft in 2019.

Although the pain of design, certification and entry into service is over for the A350-900, a tougher task for Airbus is ramping up production and introducing its larger sibling. Systems installation architecture is in place and assembly of A350-1000 sub-components – including the centre wing box, pylon and Section 15 lateral junction panels – has begun.

Over at Rolls-Royce, the first Trent XWB-97 (the -84 powers the A350-900) destined to fly on the Airbus A380 flying testbed is in the "final stages of assembly" and will be delivered to Toulouse in July. "The flight test engine is very close to certification standard," says Simon Burr, chief operating officer for civil large engines.

When it comes to marketing its widebodies, Airbus's big themes will continue to be the breadth of its range, and the breadth of its cabins. Even before the A330neo launch, Leahy was insisting that Airbus's offering of essentially the A330, two A350s (if you discount the -800) and the A380 was more than a match for Boeing's three 787s, two 777s and the 747-8, especially as, he suggests, the longer-range version of the A321 is a possible rival for the 787-8.

"Better comfort in every cabin" is Airbus's other mantra around the Paris air show, with the airframer developing its advertising campaign of last year, which stressed its use of 18in economy-class seats in both the A330 and A350. Almost every 787 has been delivered with 17in seats, says Airbus, and the only way Boeing will be able to compete with the A350-1000's economics on the 777X is by having 10-abreast economy cabins with 17in seats, as opposed to Airbus's nine 18in seats.

While Boeing's widebody offering remains a force to be reckoned with, with the 777X likely to continue where the 777-300ER left off as the leader in the ultra-long-haul market, Airbus is holding its ground – with the A350 and A330neo between them taking a 40% share of latest generation widebody orders, against 60% for the 787 and 777X combined. And when it comes to its next new product development, Toulouse may consider that a stretch of its A350-1000 – an A350-1100 – may do better in capturing more long-haul dollars in the 2020s than an A380neo. ■

Additional reporting by David Kaminski-Morrow

New variants of the A330 will be powered by Rolls-Royce Trent 7000s

Airbus

GREAT WIDE HOPE

Airbus had much catching up to do after Boeing took the initiative with the 787, but a conscious focus on conventional design and a speedy certification campaign have put the airframer back on track with the A350

DAVID KAMINSKI-MORROW TOULOUSE
CUTAWAY **TIM HALL**

For at least a decade the name 'A350' was a phantom designation, an identity in search of an aircraft.

In that time it had been used loosely to refer to a possible Airbus rival to the Boeing 747, before Toulouse caught 'eight fever' and branded its double-deck A380 accordingly.

The spur for the A350's development was the airline market's desire for a middle-market successor to the Boeing 767, a jet in the 250-seat category powered by highly efficient turbofans.

Boeing, which had failed to stir interest in a stretched 747 and whose brief dalliance with the Sonic Cruiser concept had an air of desperation, was suddenly enchanting customers with its 787.

Airbus's preoccupation with the A380 left it unprepared for the 787's mass appeal. In an effort to catch up, it hung the A350 tag on warmed-over versions of its A330, but struggled to convince customers that – despite a reworked wing and fresh engines – the end result was really as new as its number-change suggested. Boeing underlined the point by running a sarcastic campaign portraying frustrated Airbus designers hurriedly taping an 'A350' sticker on a crudely hacked-up A330 model.

Airbus

Vietnam Airlines to receive first A350 this year

Belatedly acknowledging that Singapore Airlines, lessor ILFC and other top-tier clients would not be satisfied with anything less than an all-new design to counter the increasingly popular 787, Airbus peeled the A350 label off its revamped twinjet and rethought its strategy.

If there was a risk of the A350 brand becoming stale, the airframer put aside such concerns when it unveiled a new family concept in 2006 – although it opted to distinguish this larger aircraft by underlining the spaciousness afforded by its "extra-wide body".

TWO BECOME THREE

Airbus envisaged the A350 XWB as a family of three – the keystone -900 flanked by a smaller -800 and a stretched -1000, spanning a 270- to 350-seat range – rather than the two previously proposed.

Three variants of the A350-900 have

Airbus began test-flying the A350-900 around seven years after programme launch

Airbus

emerged, with maximum take-off weights at 268t, 272t and 275t. As of May the aircraft is being marketed as a 322-seat jet with a range of 7,600nm (14,100km).

The -800 was effectively abandoned, ironically after Airbus opted to re-engine the A330, and pressure for greater -1000 performance led to a revamp in 2011 to raise maximum take-off weight from 298t to 308t and enhance its range.

Just shy of seven years after it presented the XWB, Airbus started test-flying the A350-900, commencing a certification campaign that would prove remarkably smooth and enable the airframer to claw back some of the time it had surrendered to the 787 – which, to Airbus's benefit, had endured a far less straightforward path to service entry.

Airbus attributes the swiftness of the certification partly to a conservative decision to stay on the side of conventional design. The A350's power system features bleed-air architecture from its Rolls-Royce Trent XWB engines – less adventurous than the electrical complexity of the 787, which draws heavily on lithium battery power. Even the A350's planned incorporation of limited lithium power was initially shelved in favour of nickel-cadmium as – in the wake of regulatory uncertainty over lithium cells – Airbus adopted a devil-you-know attitude to keep the certification on track. Lithium will succeed nickel-cadmium on production A350s from around 2016.

Just over half of the A350 airframe is constructed of composite materials, which had been present only on the fringes of the A330 – its fin, cowls, fairings and control surfaces. Airbus opted for a simplified long carbonfibre four-panel structure for the fuselage, with the forward, centre and aft sections comprising essentially a belly, crown and two side shells. The long panels are attached longitudinally and reduce the need for circumferential joining, lightening the overall structure.

> **"The network of partnerships has not been easy to achieve, but it is a huge asset"**
>
> **DIDIER EVRARD**
> Executive vice-president programmes, Airbus

CORRECT FUNCTIONING

Dual-circuit hydraulics operating at 345bar (5,000psi) are based on the A380's system, while Airbus used a distributed conductive network – the 'electrical structure network' – to provide the conditions required for correct system functioning within the composite fuselage.

Its wing surfaces and engine nacelles are built from monolithic carbonfibre with sandwich structures for the wing-root fairing, spoilers, ailerons and wing-tips. The large wing required a new manufacturing approach at Broughton, Airbus's UK wing centre, where the need to grapple with new automated drilling systems forced a three-month delay in service entry.

"Every section has been a challenge," says Didier Evrard, who led the A350 programme. "Sometimes we didn't have the technology in the beginning. Like for certifying the composite fuselage.

"Then we had to learn how to install systems in the composite fuselage – particularly the electrical systems. But again, it was a question of developing the right rules first, to make sure everything was safe, and then developing a solution against these rules."

Advanced production techniques for the A350 have included additive layer manufacturing, so-called 3D-printing, with over 1,000 such lightweight resin parts used in the initial production aircraft, according to US-Israeli specialist Stratasys.

As the aircraft has been refined, says Evrard, the airframer has been able to reduce its initial over-cautiousness in the interpretation of its requirements, shedding unnecessarily extensive wiring protection, he says, or taking away surplus brackets. "We're getting rid of this complexity," he states.

A350 DEVELOPMENT TIMELINE

Launch*	Dec 2004
Relaunch**	Jul 2006
First flight	14 Jun 2013
Certification	30 Sep 2014
First delivery	22 Dec 2014
Service entry (-900)	15 Jan 2015
Service entry (-1000)	Due mid-2017

*As A330 derivative **As clean-sheet design – XWB

Using a single three-dimensional digital master for the A350 "really has made a difference" to development and production, says Airbus chief operating officer Tom Williams. "The number of design query notes is significantly less," he says. "We don't see the same problems as on the A380 in terms of customisation."

Unlike the A330, the fuselage design gives the aircraft a parallel-wall cross-section between the forward and aft pairs of exit doors, to avoid compromising the cabin width at the rear.

The 5.6m (18.4ft) interior cabin, from which the 'XWB' designation derives, is wider than the 787's and sufficient for a nine-abreast economy layout with 18in seats; the narrower A330 could only manage eight-abreast. Among the cabin enhancements are the larger passenger windows with an area of 145in^2.

Airbus estimates that the turnaround time for the A350-900 will be around 61min, based on a nominal load of 315 passengers in a two-class layout with a 48-seat business cabin.

This assumes that two airbridges are used, one for each of the forward left-hand exits. The turnaround time is 2min longer than that of a 300-seat A330-300.

For the A350-1000, which will have typical seating capacity of 366, the airframer believes that turnaround can be achieved in 70min.

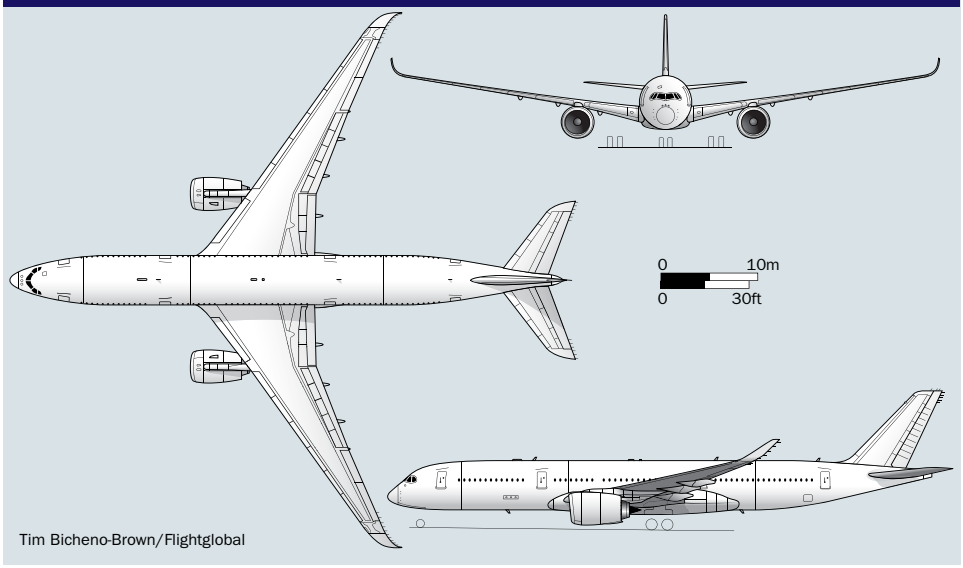
Airbus resisted a composite nose, preferring the strength of aluminium alloy for the cockpit, and adopted design features of the A380.

FREEING REVENUE

The cockpit profile of the pre-XWB iteration had been refined in a bid to accommodate an underfloor crew rest area, freeing valuable revenue space. But Airbus reconsidered the nose for the XWB, adopting a distinctive aerodynamic profile closer to that of the A380 and using the space beneath the cockpit to mount the nose-gear further forward. The crew rest area instead was shifted to the forward crown above the passenger cabin.

Out went the four-window concept for the cockpit, replaced by a six-window arrangement similar to the A380's. Crew emergency exit would not be through the windows but instead via a roof hatch.

AIRBUS A350-900



Tim Bicheno-Brown/Flightglobal

Carbonfibre wings are critical to the A350's economics, and the wing-tips – a blended upward-swept rake design – increase the span to almost 65m (213ft), matching that of the Boeing 777-300ER. The A350's wing, at 443m^2, has 20% greater area than the A330's, combined with a 3° increased leading-edge sweep of 35° to nudge the aircraft's cruise speed upwards to Mach 0.85.

> **"We learned a lot from the Trent 900 which was integrated into the XWB"**
>
> **JOHN RISHTON**
> Chief executive, Rolls-Royce

Aerodynamic enhancements to the wing, compared with that of the A330, include the use of an inboard droop-nose device on the leading edge. This was originally adopted for the A380, providing a relatively simple high-lift capability without the complexity of creating a slat mechanism suitable for the deep wing root.

Six slats are installed on the outboard leading edge, while the trailing edge features a simple single-slot flap layout that generates performance benefits through behavioural tweaks. Rather than extending in a line perpendicular to the wing sweep, the flaps deploy parallel to the slipstream to reduce drag. Airbus has also implemented a variable-camber capability, and the mechanism allows a differential setting between the inner and outer flaps. After retraction the flaps can be set at different rest positions that enables the wing loading to be better optimised to the aircraft's weight by shifting the centre of lift across the span.

There are seven spoilers on each of the A350's wings, compared with six on the A330's. To improve the wing's high-lift performance, Airbus has designed the spoilers to deflect slightly downwards during flap extension, smoothing the airfoil profile at the wing-flap interface.

With a maximum taxiing weight of just under 269t, the A350-900 is one of the heaviest airliners to use a four-wheel main bogie without the support of a centre gear, like the A340-600 or Boeing MD-11.

The lateral spacing of the main wheel is over 1.7m, compared with 1.4m for the A330, giving the A350 characteristically long axles.

While the A330's main-gear bogies are held in a trailing position by an articulating link, with the rear wheels low, those on the A350 are not.

The A330's main-gear assembly has a single side-stay for stability. But Airbus designed the main gear of the A350-900 with a double side-stay arrangement that enables better distribution of loads on the composite wing and avoids unnecessary reinforcement.

Within the cockpit, integrated modular avionics reduce electronic connections and complexity, while the layout presented to the pilots simplifies that of the A380 while retaining its capabilities.

Airbus

Boeing's clean-sheet design for the 787 forced Airbus to look beyond offering a revamped A330

Crucial to the programme has been the strategy of maintaining a common type rating with the A330 for pilot training. This approval enables crews who carry A330 qualifications to switch to the A350 with just a minimal differences-training course.

This eliminates the need for full-flight simulator operations and slashes the transition time to about a week.

Primary information display is on six identical screens – fewer than the 10 in the A380 but, at 15in, much larger than those of the A330. The size is intended to provide visual clarity as well as flexibility in the way data is presented to crews, notably through split-screen viewing and interchangeability.

RIGHT ANGLES

Each of the two pilots has one screen for flight and navigation data and a second for the onboard information system – featuring charts and other aeronautical items, such as manuals and equipment lists, for quick access and paper document reduction. The screens are angled for cross-cockpit visibility and automatically reconfigure in the event of display failure. Pilots interact with the screen data via a keyboard cursor control unit in the pedestal.

Airbus has maintained its signatory side-stick control and non-back-driven thrust levers. There is also commonality in configuration management systems including the flap, speedbrake and landing gear controls, as well as in the overhead panel layout.

But while the layout and flight controls are designed to retain familiarity, Airbus has rethought features of the cockpit to simplify crews' workload and take advantage of technology introduced on the A380.

Features include a vertical display profile to give pilots greater situational awareness through a side-on view of the flightpath. Airbus has aimed for better information access through the electronic centralised aircraft monitoring interface, including revised checklist presentations and recommendations in the event of failures.

The airframer's brake-to-vacate system allows pilots to prepare for a specific runway exit while still on approach, using a combination of the auto-brake system and flight controls to slow the aircraft and reduce runway occupancy.

Part of the standard avionics package on the A350 is the runway overrun protection system that was originally approved for the A380 in 2009. The Airbus-developed system collates information on the approach runway condition and contrasts it with the weight and configuration of the aircraft, to analyse the risk of an overrun.

If it calculates a mismatch the protection system can sound a warning to the crew, enabling them to execute a missed approach or take other precautions to ensure that the aircraft is able to stop safely in the available distance.

A350 VARIANT SPECIFICATIONS

	A350-900	A350-1000
Length	66.80m	73.78m
Height	17.05m	17.08m
Wing span	64.75m	64.75m
Wing area	442.9m^2	459.7m^2
Fuselage width	5.96m	5.96m
Maximum cabin width	5.61m	5.61m
Basic MTOW	268t	308t
Accommodation	322	366
Engine thrust	374kN	432kN
Range	7,600nm	7,950nm

SOURCE: Airbus

"We developed the right rules first... then developed a solution against these rules"

DIDIER EVRARD
Executive vice-president programmes, Airbus

Mounted in the centre pedestal between the pilots' seats is an integrated radio-management system, like that on the A380, and the A350 also features refined datalink interfaces for air traffic control.

As well as providing the capability for precision navigation, the flight management system is designed to ease workload by enabling the crew to explore the performance impact of possible failure scenarios along the route. The A350's autopilot has also been enhanced to cope with small excursions outside of the normal flight envelope.

Airbus has provided flexibility that enables airlines to maintain differing electronic flight-bag options, by allowing crews to use their own laptop computers to integrate with the aircraft's avionics systems.

While General Electric's GEnx engine had been poised to power the original A350, with Rolls-Royce subsequently offering the Trent 1700, emergence of the XWB spurred development of a new R-R powerplant – one which would quietly edge GE off the programme.

UPPING THRUST

The sixth production engine to bear the Trent designator, the Trent XWB was intended to deliver the expected 75,000-93,000lb-thrust (334-413kN) range covering all three A350 XWB airframes.

But the decision to raise the thrust of the A350-1000, part of a redesign to increase range and broaden the type's appeal, resulted in an engineering divergence between the XWB-84, common to the A350-800 and -900, and the XWB-97 for the -1000.

Maintaining the three-shaft design of Trent predecessors, the XWB built on the technology of the Trent 900 and 1000, and became the largest of the family, with a 3m (118in) fan comprising 22 titanium blades.

It has an eight-stage intermediate-pressure and a six-stage high-pressure compressor, notably incorporating bladed disk, or 'blisk', technology in the first three stages to save weight and improve aerodynamic efficiency.

"We learned a lot from the Trent 900 which was integrated into the XWB," says outgoing R-R chief executive John Rishton.

"We've done everything better – there's a better compressor, better materials, higher temperatures. Everything about it."

The high-pressure turbine is single-stage but the Trent XWB features a two-stage intermediate-pressure turbine, an architecture intended to avoid inefficiency in the intermediate section, and provide greater thrust with a lower fuel burn. Its six-stage low-pressure

Airbus

Hong Kong's Cathay Pacific has ordered 26 A350-1000s, partly by converting an order for 16 -900s

» turbine is designed to be short and light, using semi-hollow blades.

Changes to the bearing load management system shifted the low-pressure system support forward, to the front bearing housing, compared with conventional Trent powerplants. Although heavier, the arrangement generates an improvement in fuel consumption.

Rolls-Royce has used composites for the rear fan case and employed a single-skin combustor casing to reduce weight.

The Trent XWB has been designed to meet stringent noise targets of QC1 for departures and QC0.5 for arrivals. Rishton says the initial two in-service aircraft for Qatar Airways have been "delivering what we'd expected" in terms of fuel-burn. "Both aircraft and their engines are performing very well in service," he adds.

"The performance of the turbine is great, we feel good about it"

SIMON BURR
Chief operating officer for civil large engines, R-R

Qatar's lead aircraft had accumulated some 1,500h and more than 350 cycles by the end of May. Chief operating officer for civil large engines Simon Burr says the dispatch reliability for the Qatar Trent XWB reached 100% over the four months from the beginning of February 2015. "It's gone through some interesting weather, sandstorms, and it's in great shape."

Singapore Airlines' first of 70 A350s is scheduled for delivery in the first quarter of 2016

TEST CAMPAIGN

The manufacturer is focused on preparing its XWB-97 for the A380 flying testbed. It will run in June and be delivered to Airbus in July, where a 120h test campaign is scheduled to start in October.

Although the -1000 has higher thrust requirements, R-R reasoned that the performance of the XWB-84 version, particularly the fuel consumption and cool operating temperatures, meant that the XWB-97 could be designed with an enlarged core but retain the -84's fan size.

However, internal changes will include an unshrouded high-pressure turbine. "We've done a lot of work on that, to control the clearances very closely," says Burr. "The performance of the turbine is great, we feel good about it. The fan is running a bit faster, [the core] a bit hotter – but it's not a 'hot rod', we're comfortable with the temperatures it's running at."

Airbus is closely monitoring Qatar's early experience with the A350-900. "This is the period to learn all the remaining maturity," says Evrard. "It can be small things, linked to cabin use. Things you can't see before you operate in an airline environment. We've deployed a significant team in Doha to capture all these findings."

Confident that the -900 is achieving a relatively trouble-free service entry, and with 21 -900s in final assembly at the end of May, Airbus is increasingly concentrating on the -1000's development.

Airbus officially lists the -1000 as a 366-seat aircraft and puts its range at around 8,000nm with maximum passenger payload. The airframer says it can accommodate up to 440 passengers in a high-density layout and its most recent airport compatibility data on the aircraft shows an optional 'type C' exit between the aft main doors to meet evacuation requirements in certain configurations.

Despite the divergence created by its 2011 redesign, the -1000 still maintains strong commonality with the -900, with the primary differences – other than the 11-frame fuselage stretch and XWB-97 engines – comprising an extended trailing edge and six-wheel main gear.

But there are also smaller details that have been incorporated into the design. The -900's metallic door surrounds are composite on the -1000. It will feature electric landing gear door opening mechanisms, and a simplified installation of floor electrics. The aircraft also has an optional new aft galley layout option, and interior cabin studies are under way to achieve a 20-seat increase in accommodation by 2020.

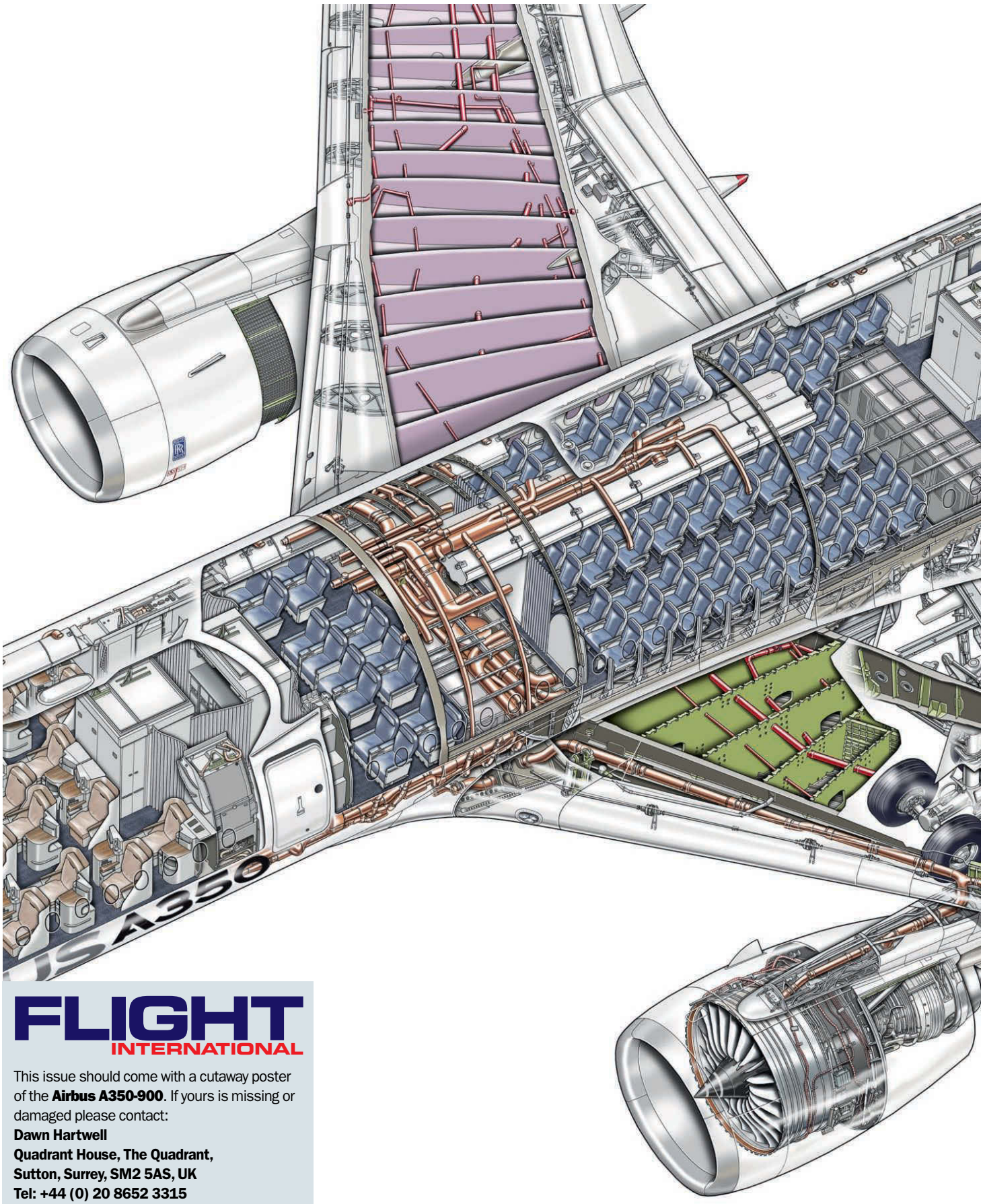
"Full structure design maturity and systems installation architecture is complete," says head of A350 programme development Bruno Hernandez. "We've started production in all the plants."

Substantial component assembly has commenced, including the fixed trailing edge, pylon, centre wing-box, lateral junction panels and carbonfibre door surrounds. Entry to the final assembly line is scheduled for early 2016.

Evrard says that Airbus tasked itself with the "highest development of maturity" on service entry for the A350, and says he is "very positive as to what's been achieved" with the 'Airline1' process – designed to mirror carrier operations before delivery.

"Within the supplier community we have a lot of support," he adds. "The network of partnership built around this aircraft has not been easy to achieve, but it is a huge asset." ■

Read our flight test of the A350-900 at flightglobal.com/a350ft



FLIGHT INTERNATIONAL

This issue should come with a cutaway poster of the **Airbus A350-900**. If yours is missing or damaged please contact:

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Testing out vertical landing procedures with an F-35B aboard the assault ship USS *Wasp*

US Marine Corps

ALMOST READY FOR DUTY

It may yet have to make its debut at a major air show, but, in a major step forward for the programme, the first variant of the F-35 is finally about to be declared operational

JAMES DREW & **STEPHEN TRIMBLE**
WASHINGTON DC

On an Arizona runway nearly 4,900nm (9,060km) away from Le Bourget's festivities, 10 selected Lockheed Martin F-35Bs will be preparing to make history as the Paris air show gets under way.

The US Marine Corps (USMC) is set to declare later this year the 10 F-35Bs assigned to the VMFA-121 Green Knights squadron at Marine Corps Air Station Yuma, Arizona, as the first unit to achieve initial operational capability (IOC). Nearly 14 years after the US Department of Defense awarded Lockheed the Joint Strike Fighter development contract, the first of the three F-35 variants will finally be an operational system.

The short take-off and vertical landing (STOVL) F-35B has still not attended an international air show, but it will soon be available for combat. Not much is likely to change for VMFA-121 in the months following the IOC declaration. The unit will be available for operations if called on, but it is not scheduled for its first deployment – to Iwakuni, Japan – until 2017. By that time, the US Air Force should have declared the first squadron of the conventional take-off and landing F-35A to have achieved IOC, with the US Navy following suit in 2018 with a first squadron of carrier-variant F-35Cs.

"We're on track to do that [marines IOC] and on track for air force IOC the following year," assistant secretary of defense for acquisition, technology and logistics Frank Kendall told reporters on 29 May adding that, after that, the navy and international partners would start declaring IOC.

"We're continuing to execute to the plan that was baselined in 2011, so good progress on all of those things. We're either meeting or exceeding our projections for cost and schedule."

Getting to this point has been a struggle, especially for the F-35B. As the world's first

operational fighter that combines supersonic speed and STOVL capability, the model is a technological breakthrough. In fiscal year 2015, each propulsion system alone – Pratt & Whitney F135 engine, Rolls-Royce LiftFan and other major components, such as wing-mounted roll-posts and a three-bearing exhaust swivel nozzle – cost $32 million.

LOGISTICS ISSUES

Proving the F-35B can operate reliably on an amphibious carrier was the last remaining hurdle before the marines could declare IOC. In previous tests aboard the amphibious assault ship USS *Wasp* in 2013, the F-35B showed that it could take-off and land as designed. But the deployment revealed other issues, particularly in the logistics department.

It was discovered, for example, that the system the USMC currently relies on to automatically monitor and diagnose faults, order repairs and keep track of spare inventories – Lockheed's autonomic logistics information system (ALIS) – could not fit aboard the *Wasp*. So, all maintenance actions were co-ordinated remotely from Lockheed's global F-35 sustainment hub in Fort Worth, Texas. As a result, the programme funded a deployable version of ALIS, which accompanied the F-35B squadron on the latest round of embarked tests.

One final operational assessment staged aboard the *Wasp* from 18 to 27 May was intended to answer the ALIS issue and many other questions about the F-35B's ability to go to war.

Ninety-one marines, including 10 pilots, joined six F-35Bs – a shipboard squadron – aboard the *Wasp* in the Atlantic Ocean for eight days of flying, which included 108 sorties in 85.5 flight hours. The pilots flew sorties focused on carrier qualification, air interdiction, defensive combat air, air traffic management and supporting a rescue mission for a simulated downed aircrew.

"I would say highly successful," says Lt Gen Jon Davis, the USMC's deputy commandant for aviation.

Although the public focus was on the number of sorties, the service was most interested in what was happening on and below deck. "We focused this carrier period on logistics and sustainability," Davis says. "So, what would it be like to go do that and what would it take to include a lot of force maintenance actions, both above deck and below deck. That all kind of worked how we thought it would. There were a couple of small things we discovered – an additional tool here or an additional part there, but the bottom line is we accomplished all of the stuff we wanted to, to include flying an [F135] engine on board the ship on the [Bell Boeing] V-22."

> **"We are tracking additional items to accomplish our IOC objectives"**
>
> **LT GEN JON DAVIS**
> Deputy commandant for aviation, US Marines Corps

The size of the F135 engine had raised concerns that one could not be physically loaded and carried by a V-22 from the shore or another ship to an amphibious carrier deck. However, the US Naval Air Systems Command, Bell Boeing and P&W developed a cradle for the F135 to load inside the tiltrotor, ensuring that spare engines could be dispatched to the ship if needed.

US Marine Corps

In May six F-35Bs were put through operational assessments in the Atlantic Ocean, clocking up more than 85 flight hours

US Navy

Transporting an F135 engine from a V-22

"We flew it on on the 21st of May and flew it off on the 27th, and moved that thing around like we were putting it into an aircraft," says Davis.

A thermal coating on the deck also "performed well", Davis adds. The F135 engine produces nearly twice the thrust of the R-R Pegasus engine on the Boeing AV-8B Harrier, and the heat exhaust emitted by the F-35 during a vertical landing can melt an untreated carrier deck. So the protective coating makes sure the aircraft can operate safely aboard ship.

Most importantly, the deployable version of ALIS also "worked very well" aboard the ship, Davis says. That "allows us to achieve our turnaround times," he adds. "We have good interoperability with ALIS on board the *Wasp*, and there's an organic system now on that ship."

LOW RADAR SIGNATURE

Maintaining the F-35B's very low observable signature to radar was another objective of the last deployment. Previous stealth aircraft required extensive post-flight maintenance to re-apply radar-absorbent materials and adhesives that cover gaps on panels.

"We proved we could do that at sea as well," Davis says. "All in all, a successful deployment. We got what we wanted out of the shipboard period, and now we are tracking the additional items we have to do to accomplish our IOC objectives."

In general, the IOC term in the military's acquisition lexicon means that a new weapon system meets the user's minimum operational needs. For the F-35B, this is defined as the ability to carry internally two 454kg (1,000lb) bombs or two 227kg bombs and two Raytheon AIM-120 AMRAAM air-to-air missiles.

It also includes a suite of software-enabled capabilities that are only partially complete. In 2010, the marines agreed to declare IOC in 2015 with a degraded software build called Block 2B, while the USAF is waiting for Block 3I software in 2016, which includes updated hardware. The navy's IOC declaration is waiting for the availability of Block 3F in 2017.

In March, F-35 programme executive officer Lt Gen Chris Bogdan acknowledged that a


US Marine Corps

The STOVL version of the F-35 sets off from the deck of the USS *Wasp*

» portion of the Block 2B software capability would not be ready when the USMC's window for declaring IOC opens in July.

One of the reasons for calling the F-35 a "fifth-generation fighter" is the aircraft's ability to fuse data from multiple sensors, both on board and from other aircraft. The pilot can use that information to track and positively identify targets that could not be identified using a single sensor. But the Block 2B software's fusion algorithms are still not working properly.

In formations of more than two aircraft, the F-35's sensor fusion computer often gets confused: each sensor detects a target with varying degrees of resolution, and so the pilot is told by the computer that there are several targets where there is only one.

FUSION ENGINE

It is a problem that the navy encountered when developing a similar sensor fusion engine for the Boeing F/A-18E/F Super Hornet, programme manager Capt Frank Morley told Flightglobal in a recent interview. For the Super Hornet, the air-to-ground capability that is causing problems for the F-35B's Block 2B software was still challenging, but turned out to be the easy part. Making the sensor fusion algorithms work in an air-to-air environment in three-dimensional space was much more difficult, Morley says.

"We spent about nine months beyond what we expected just to work out the kinks on that," he says.

The F-35 programme is scheduled to start testing a fix for the sensor fusion problem in a few weeks, Bogdan says. But the marines could declare the first F-35B unit operational before the fix is ready.

"The fixes we are getting ready to flight test for some of the deficiencies we found in our fusion algorithms and some of our pilot vehicle displays are actually being tested on our Block 3I software," Bogdan says. "Once we complete that, we will go back and retrofit all the 2B airplanes with those fixes. We intend taking that 3I software with the fixes to flight test around the last week of June. We'll spend about 30 days flight testing those fixes, and if they appear to be good, then we will just leave those in 3I for the future airplanes and port them back into 2B."


US Marine Corps

A range of maintenance operations were tested on six of the deployed aircraft

> **"We intend taking that 3I software to flight test around the last week of June"**
>
> **LT GEN CHRIS BOGDAN**
> F-35 programme executive officer


US Marine Corps

Ten F-35Bs assigned to VMFA-121 will achieve initial operational capability soon

As the software is being fixed, the F-35 programme is finally preparing to enter a new phase. The long period of development and testing will begin to wind down in two years. Meanwhile, Lockheed's factory has been stuck in a holding pattern for three years, delivering F-35s at an average pace of about three aircraft per month to US and international customers.

If the Pentagon's budget is cleared by Congress and international customers buy their expected share, F-35 deliveries could increase by about five-fold over the next five years. The Department of Defense is continuing to negotiate a block-buy deal for the next two years, but is already looking to negotiate a three-year block buy of more than 400 aircraft.

Bogdan first floated the idea of a multi-year, bulk acquisition of the F-35 at the Farnborough air show last July. More details of the proposal were released in March. The programme office issued a pre-solicitation notice for a proposal to buy as many as 477 F135 engines on a single contract covering a three-year period, with no spare engines included.

If Congress authorises the multi-year deal, Lockheed and its supply chain may be able to achieve the economies of scale required to drive the unit recurring flyaway price of the F-35A from $108 million a year ago to about $80 million in fiscal year 2019, as programme officials have promised. Although the programme has invested $170 million to fund cost-saving initiatives, Bogdan has said that four-fifths of F-35 cost reductions come from increasing the production rate to achieve economies of scale.

But Kendall's staff will be watching the negotiations carefully. Multi-year acquisition deals are generally approved only when the contractor agrees to reduce unit costs by more than 10%, which in the case of the F-35 can amount to $8-10 million reductions each year of the deal.

"I'd like to see double-digit savings, not very different from what we try to do with a multi-year," Kendall says. ■

AGE CONCERN

Northrop Grumman

The B-2 programme provides an historical example of the air force not always getting what it wants: 132 were requested, but it received just 21

As the USA continues to rely on vintage bombers, progress on their highly classified replacement is being seen as critical to maintaining this strategic defence capability

JAMES DREW WASHINGTON DC

In April, Russian defence minister Sergei Shoigu sent a quiet ripple through the American national security community, when he proposed restarting production of the former Soviet Union's most sophisticated Cold War bomber – the supersonic Tupolev Tu-160, or "Blackjack".

To those who took notice in Washington DC, the announcement delivered at the Tu-160's Kazan aircraft production plant was a clear signal from the Russian government that it will rely more heavily on its military muscle – conventional and nuclear – to meet foreign policy objectives going forward.

The signal could not have been clearer, coming just as the USA prepares to begin development of its own bomber: one advertised as a long-range, nuclear-capable penetrating weapon with unmatched technology in stealth, surveillance and communications.

"As one general told me, [Russian president Vladimir Putin] is a master at nuclear poker," said the Air Force Association's (AFA) Peter Huessy, a long-time nuclear policy analyst, when asked about the Tu-160 plan in an interview. "Unless we're willing to get in the game, they're going to call our bluff all the time."

And whether the USA will get in the game is exactly the question many in Washington, and among its allies around the globe, are asking as the country's strategic and conventional bomber forces age out.

US allies in Europe and Asia might be understandably confused seeing their number one strategic defence partner flying 53-year-old Boeing B-52 bombers with vintage production engines that billow exhaust fumes, and carrying air-launched cruise missiles built in the 1980s.

> **"The essence of the US Air Force is to hold at risk any target anywhere in the world"**
>
> **MAJ GEN GARRETT HARENCAK**
> US Air Force

"If you want to maintain our position as the world's sole superpower, if we want to be able to execute the tenants of our nation's security strategy, we need a new long-range strike aircraft," says former three-star general David Deptula, now dean of the AFA's Mitchell Institute. "We are operating geriatric aircraft that simply cannot accomplish the missions that our national security strategy calls for."

Fortunately for the USA, development of a new bomber could start as early as this summer, with the selection of either Northrop Grumman or a Boeing-Lockheed Martin team to carry the project forward.

HIGH-COST VENTURE

Both bidders have the know-how and the manufacturing capacity to support such a large and complex undertaking, which the Department of Defense expects will cost at least $55 billion, not including development, for the production of between 80 and 100 aircraft.

But pushing the programme over a fiscal hump between 2022 and 2025, when activity would peak, would be the more herculean task for the winning bidder. This is because defence spending in the USA is capped by law, meaning the Long-Range Strike Bomber (LRS-B) programme, as the next-generation bomber project is known, will continually be at risk of cancellation or cuts as it competes for limited resources against other "critical" military aircraft programmes like the Lockheed F-35 Joint Strike Fighter, the Boeing KC-46 Pegasus tanker and the next-generation trainer, or T-X. The US Navy also needs more than $100 billion over the same period, to replace its ageing Ohio-class ballistic missile submarines.

Although the air force hopes to build at least 80 of the heavy bombers at $550 million »

» apiece in 2010 dollars, history has many examples of programmes that failed to make it over the fiscal hump and were terminated.

The USAF wanted 132 Northrop B-2 Spirit stealth bombers, but got just 21, including one test aircraft. It wanted 381 Lockheed F-22 Raptor air superiority fighters, yet production was halted at 195. Today, it wants 1,763 F-35As, although the fifth-generation fighter's $100 million per-unit price tag has observers wondering if that planned quantity is actually achievable.

Speaking at a recent AFA event, air force acquisition executive Dr William LaPlante said that whether the service reaches its planned bomber procurement number will not be up to him. That is because the bomber's funding requirement will peak at about $9 billion in fiscal year 2022, before receding to $7.5 billion in FY2025, according to the DoD's top acquisition official, Frank Kendall.

"It's really going to be up to future leaders," LaPlante says. "All we can do is set the programme up. But it's absolutely true that historically we don't buy as many airplanes and ships as we say. Sometimes we buy more, like [Lockheed] F-16s. It goes either way."

Both industry teams vying for the LRS-B contract know first-hand the pain of cut quantities.

Lockheed and Boeing partnered to build the F-22, which the companies claim was a successful venture, despite cost overruns and programme delays that were eventually the Raptor's undoing.

Defense Secretary Robert Gates cancelled the F-22 in 2009, and the last aircraft rolled off the production line in late 2011. The supercruise-capable jet made its combat debut late last year in Syria, and the fleet is currently flying routine missions in the Middle East, while also supporting the homeland defence mission.

Northrop designed and built the B-2, the world's first true stealth aircraft. But support in Washington faded because of cost overruns and its ties to the nuclear mission at the end of the Cold War. Production ceased just as it was scaling up, resulting in a cost per aircraft of $1.7 billion in today's dollars.


US Air Force

Flare for it: the air force's B-1B fleet is 28 years old, and should stay in service until 2040

BARGAIN BUY

"Well worth it," says Maj Gen Garrett Harencak, air force assistant chief of staff for strategic deterrence and nuclear integration. "Whatever cost you come up with, and there are wild numbers out there, the B-2 has been a bargain for America – trust me."

Whichever team wins the bomber contract, they will have to work doubly hard to keep the programme on track to ensure continued support from Congress, the administration and the Pentagon.

But how do you sell a multi-billion-dollar 'ghost'? The programme is highly classified, and only a select group of officials actually know what is being purchased. In fact, the only unclassified line in the bomber's budget sheet is its cost. The USAF has asked Congress for $14 billion to support the activity through 2020, according to the programme's latest five-year spending plan.


US Air Force

B-52s still play a central role in the US fleet

"Any time there's a programme that requires a significant degree of investment like this one will, there will be anti-bodies accumulating, because people will view it as a cash cow, particularly those who don't understand the value it provides to the nation," warns Deptula.

According to the Center for Strategic and International Studies' Clark Murdock, no other nuclear power invests as little on its nuclear force as a percentage of its defence budget as the USA. The DoD currently spends 4-5% of its $600 billion top line on strategic nuclear weapons, and even in the fiscal "bow wave" due to occur in the 2020s, the number will still be lower than Russia's and China's, at 8-9% of the total defence budget. Their annual defence budgets are much smaller, however.

Murdock says the USA must spend more on its strategic nuclear force, to include delivery of the bomber. But with the defence budget arbitrarily capped by law, each new programme must jostle for space.

"Everybody's trying to sneak their nose into the tent," he says. "In this area where you're cost-capped, you have to be much more disciplined about deciding what's really important, and what's less important. Identify your must-have capabilities and adequately fund them."

The house and senate armed services committees intend to trim the FY2016 request by $460 million to $786 million, to account for a four-month contract award delay, which has left the programme front-loaded with surplus cash.

Northrop, Boeing and Lockheed are staying tight-lipped about the competition, only issuing general statements highlighting past achievements. There is very little, if any, concrete information about the companies' competing design proposals.

Boeing is confident its defence business will secure either the bomber project or the next-generation T-X trainer, and its selection

US Air Force

Cost overruns hit the B-2 programme

late last year to deliver the next presidential aircraft should soften any blow.

"We are optimistic also about our prospects this year for winning the long-range strike bomber programme," Boeing chief executive Jim McNerney said at an investors' conference in May.

Some analysts have suggested Boeing might move to acquire Northrop to beef up its defence business, if it loses the bomber competition.

"Would there be some big acquisition? Probably not," McNerney says. "We'd regroup and regrow organically, but I think chances are we're going to win one of those programmes."

Winning the bomber competition is a much bigger deal for Northrop, but its chief executive, Wes Bush, told investors recently that he is not betting the company on it.

Northrop is leaning heavily on its expertise in stealth technology to make its case, having delivered the B-2. It is also pushing hard to win T-X and the Joint Surveillance Target Attack Radar System recapitalisation.

"As one general told me, [Vladimir Putin] is a master at nuclear poker"

PETER HUESSY
Air Force Association

LaPlante says the air force and the higher office of the secretary of defence try to set the conditions for a vibrant and competitive military industrial base, and it is a major consideration when awarding any large contract. But he warns that the government cannot control how those companies behave.

"They have their own investors, they have stocks, they have their CEOs who make decisions," he says. "All we can do is make sure we don't inadvertently push someone completely out of the market. So we watch it, but it's a much bigger issue than any one programme.

"You have to look at the foreign military sales situation, you have to look at the classified work. What you don't do, because it would be wrong, is sit there at the eleventh hour going into a source selection and say, 'oh, we have industrial issues'. It's all deliberate and set up."

The LRS-B programme currently has strong support within the congressional defence committees, but still needs majority support among 435 representatives and 100 senators. That support wanes among those ideologically opposed to nuclear weapons.

The nuclear link helped kill the B-2, says Huessy, and the new bomber has also become a target for arms control advocates, particularly as the air force whittles its nuclear-capable bomber force down to 60 B-52s and B-2s to comply with New Strategic Arms Reduction Treaty limits agreed with Russia.

DELAYED ADVANTAGES

Tom Collina of the Arms Control Association suggests in a report the that air force could avoid about $32 billion in expenses over the next 10 years by delaying the bomber programme until 2025 and allowing the legacy fleet to cover the nuclear deterrence mission in the interim.

Harencak is opposed to any attempt to defund or delay delivery of the next-generation bomber, saying the air force needs it, regardless of whether it carries nuclear weapons.

"If nuclear weapons, and I hope it happens, go away next year, guess what? We're still building a long-range strike bomber," he says. "The essence of the US Air Force is to hold at risk any target anywhere in the world. There is no sanctuary for anybody who might think they could threaten us or cause us or our friends harm."

Harencak says the current fleet, although still effective, is terribly old and that he hopes the air force won't ever need to rely on a 100-year-old B-52.

The average age of the current B-52H fleet is 53. The Boeing B-1B fleet is 28 years old, and the B-2 is the youngest fleet at 20. The air force currently plans to keep the B-52 and B-1 in service until 2040. The B-2 should remain in the inventory until 2058.

"You don't want to be the person to walk into the Oval Office sometime in the near future and say, 'Mister President or Madam President, I am so sorry but we cannot neutralise that threat to America because we made the very bad decision not to invest in long-range strike capabilities'," Harencak says.

Huessy says nuclear-capable heavy bombers continue to be the most flexible leg of the nuclear force, because they are a long-range, visible deterrent – perfect for military posturing and reassuring allies.

Along with delivery of the new bomber, the USAF needs to develop a follow-on to the air-launched cruise missile (ALCM), which entered service in the 1980s with an anticipated service life of 10 years. The service says the ALCM is becoming less reliable and harder to maintain due to the natural ageing of components, and that a replacement needs to be fielded as soon as possible. The air force wants conventional high-explosive and nuclear-tipped variants.

"We must get it replaced because the ALCM provides enormous flexibility and assurance to our allies, and to us," Harencak says.

The cruise missile, known as the long-range standoff weapon, had been delayed by three years on cost concerns, but the decision was reversed in the latest budget request. Almost $1.9 billion is programmed into the budget through FY2020 to begin development. ■


US Air Force

The USAF's current ALCM weapons are becoming more difficult to sustain

Jamie Hunter/Textron AirLand

Scorpion's debut appearance at Paris follows its first transatlantic visit, which included participating in two shows in the UK last July

SCORPION SHOWTIME

The rapid development of Textron AirLand's multirole aircraft has led to admiring glances – but now the programme must succeed in finding a launch customer

JAMES DREW WICHITA

When it comes to Textron AirLand's Scorpion, "seeing really is believing", and more and more people are getting that opportunity, as the company scours the globe in search of a launch customer for the subsonic, multirole jet.

The current, lone prototype went from initial design to first flight in two years, all at the company's expense. A second, improved model is in production, which the company tells *Flight International* should be airborne by the second quarter of 2016.

The prototype was first flown in December 2013, and seven months later, it appeared at the Royal International Air Tattoo and Farnborough air show in the UK. Now, less than 12 months later, Scorpion is making its debut at the Paris air show.

It will travel through Europe immediately afterwards, visiting the UK and several undisclosed NATO nations that have particular interest in the design, either as a maritime patrol asset or advanced jet trainer.

PRAISEWORTHY

The low-cost jet tends to make headlines wherever it goes, and has received praise from US Air Force officials, including Secretary Deborah Lee James – who saw the Scorpion at an air show and was briefed on its capabilities.

"I give Textron a lot of credit," James said at event in Washington DC last December. "They saw a need on the world market, and they made the investment. Who knows, for us in the future I'm thinking about our T-X [trainer] requirement."

But unfortunately, praise doesn't pay bills, and how long the joint venture with AirLand Enterprises can continue without a launch customer is the multi-million-dollar question.

Textron chief executive Scott Donnelly, whose staunch support has kept the Scorpion programme funded, says that many potential customers are keenly interested in it. In fact, Paris would be the perfect place to sign a deal.

USAF student test pilots recently trialled the Scorpion and Textron partner company Beechcraft's AT-6 light-attack turboprop from Wichita, Kansas, conducting 12 flights with the former and seven with the latter during a week-long visit. Textron says the Scorpion completed three flights per day and successfully completed all of its missions. The aircraft was returned to the air after a sortie within an average of 31min, with a best turn time of 20min, the company says.

In April, it was self-deployed to South America, to visit at least one local air force. Its more than 6,600nm (12,200km), 10-day trip included 17 sorties and 28h of flight time. It conducted six demonstration flights along the way and then participated in static displays at the US military's Southern Command and Central Command headquarters, both in Florida, before returning home on 5 May.

The Scorpion will be ferried across the North Atlantic to Paris in the first week of June.

Dale Tutt, Scorpion programme manager and chief engineer, says displaying the aircraft at such events makes the twin-engined "hunter-killer" more "tangible and real" to potential customers. "Seeing really is believing," he notes. "The airplane is a lot bigger than they expect. A lot of folks think about the T-37 and the other aircraft Cessna's built in the past. This is a much larger, tactical aircraft and it's more [Lockheed Martin] F-16ish in size than some of the smaller trainers."

Textron AirLand

The aircraft is described as "F-16ish" in size – bigger than potential customers expect

CONDITIONAL

The prototype was manufactured at Textron's Cessna plant in Wichita, where the second aircraft is now moving down the assembly line. The company is discussing building a third, but that could depend on signing a launch customer.

Tutt says governments in South America particularly want an affordable aircraft that can provide armed, persistent surveillance in a counter-insurgency role, whereas European governments tend to need a maritime patrol aircraft or advanced trainer.

The Scorpion can carry many different payloads, and its flight-critical systems are segregated so that integrating new sensors takes months, not years.

Based on feedback, the company has reconfigured the production design to include a deeper internal payload bay to accommodate larger sensors. Some possible buyers have suggested a signals intelligence payload, and in Europe there is interest in integrating missile and radar warning receivers, says Tutt.

"There are some internal changes that make it a little easier to build, and easier to maintain," he says. "We are planning to switch from a fixed, horizontal tail to a trimmable horizontal tail that will give us the full speed envelope that we're seeking. We've always expected we'd need to do that, but we wanted to get the airplane out in front of people and get that customer feedback. The airplane has flown fairly close to what we want it to be from the windtunnel testing."

> **"Who knows, for us in the future I'm thinking about our T-X [trainer] requirement"**
>
> **DEBORAH LEE JAMES**
> US Air Force secretary

Whether the first batch emerges in a tactical surveillance-and-strike configuration or as advanced jet trainers depends on which customer "pulls the trigger first", Tutt explains.

"We have several active pursuits that I think we will see movement on hopefully sooner rather than later," he says. "We don't really have to do very much tailoring of the aircraft to make it satisfy either role."

The USAF wants a next-generation trainer, or T-X, to replace its Northrop T-38 Talons, but as a request for proposals for that requirement is still a year away, a foreign buyer will likely come first. Some reports have suggested Nigeria or the United Arab Emirates as potential customers.

The Scorpion can carry up to 2,810kg (6,200lb) of ordnance and has a 617kg-capacity internal payload bay for surveillance and targeting equipment. It has a top cruise speed of 450kt (833km/h) and a ferry range of 2,400nm. Its operational cost per flight hour has been validated at $3,000, including spare parts, or $1,000 per hour when only accounting for fuel and maintenance. ■

Textron

A Beechcraft AT-6 light-attack turboprop with the Scorpion prototype at Textron's Wichita site during a USAF test pilot trial

AIRBUS FRETS ON DEFENCE FRAILTY

May's disastrous A400M crash compounded an already tough period for the company, as it looks to turn around its military unit's fortunes

CRAIG HOYLE LONDON

While the bulk of the attention at Le Bourget will be centred on the likely rush of announcements linked to commercial aircraft sales – and particularly the successes that Airbus will enjoy on home turf – the same company's defence arm will be attempting to recover after a torrid few months.

Just weeks into 2015, Airbus Group chief executive Tom Enders took the highly unusual step of publicly apologising to his UK military customer – during a company-run new year's event in London – for delays to the A400M tactical transport programme.

All had seemed well only two months before, when the UK Ministry of Defence staged an event to welcome the Royal Air Force's first "Atlas" at its Brize Norton base in Oxfordshire; even though that aircraft was grounded by a technical fault. There were, however, already strong indications that Airbus would miss a March 2015 target for the type to achieve initial operational capability status with the service – a milestone denoting the availability of seven of its eventual 22 aircraft.

As expected, Enders' promise of "management and organisational consequences" linked to the A400M's problems did not take long to take shape. On 29 January, it was announced that the head of the company's Military Aircraft division, Domingo Ureña Raso, was to leave his post. Just over one month later Fernando Alonso stepped into the role, from that of Airbus's head of flight test operations.

The problem, according to Airbus Defence & Space chief executive Bernhard Gerwert, was: "For the integration of military capabilities and the industrial ramp-up in particular, we have not been performing at the level which had been expected of us." This knowledge had already contributed to the company taking a €551 million ($614 million) charge against the programme in the fourth quarter of 2014.

Faced with having to accelerate production of the A400M, while coping with an unacceptable level of "travelled work" – referring to incomplete components and structures arriving at its San Pablo final assembly line in Seville, Spain – and also being contractually required to insert capabilities beyond the strategic-range airlift tasks currently possible with the type, the decision was taken to reduce the planned delivery total for 2015 to 16 aircraft. Announced by Airbus in late February, this would double the total of eight achieved last year, but fall short of a previous plan to hand over more than 20 examples this year.

DISASTER STRIKES

Already reeling from this combination of challenges, the programme was struck by disaster on 9 May. Just minutes into its first flight, aircraft MSN23 – the third of 10 A400Ms to be produced for the Turkish air force – crashed near Seville airport, seemingly as its crew attempted to return following a technical problem.

While images of the scene show that the

BillyPix

An A400M took part in the flying display at Paris 2013. The type was due to fly at the 2011 show, but was denied by last-minute gearbox problems

Airbus Defence & Space

As things stand, Eurofighter production will close later this decade unless more orders are secured

aircraft came to rest largely intact in a field, a fire resulted in it being completely destroyed. Four of the six Airbus flight test personnel on board lost their lives, while the other two suffered serious injuries.

The first accident to have affected the A400M since lead development aircraft MSN1 made its flight debut in December 2009, the loss has had a major impact on operations. A dozen aircraft already delivered to the air forces of France (6), Germany (1), Malaysia (1), Turkey (2) and the UK (2) were withdrawn from operational use, or in the case of France saw their use restricted pending the initial findings of the crash investigation.

Spain's defence ministry, which is leading this activity, also withdrew a certificate allowing Airbus to conduct pre-delivery flights with customer aircraft, effectively leaving the company with the ability to operate only its three-strong test fleet.

This was the point at which Airbus was planning to push the A400M towards securing fresh export orders, beyond the combined 174 aircraft already under contract for the existing five operators, plus Belgium and Luxembourg. Combined with the type's increasing level of operating experience since lead user France took delivery of aircraft MSN7 shortly after the Paris air show in 2013, the imminent end to Boeing's production of the C-17 strategic transport had appeared set to bolster interest in the Atlas.

Airbus sales success with the A330 MRTT will come under pressure from the KC-46A

On 19 May, Airbus notified users of the need to "perform one-time specific checks of the electronic control units [ECU] on each of the aircraft's [Europrop International TP400-D6] engines before next flight", along with "additional detailed checks to be carried out in the event of any subsequent engine or ECU replacement".

In an update sent to its customers on 2 June, Airbus said the crash was preceded by power-setting problems affecting three of the transport's engines. Preliminary analysis of the aircraft's flight data and cockpit voice recorders by the Spanish military's CITAAM safety agency "have shown that all other aircraft systems performed normally", it adds.

Due to the ongoing investigation and restrictions placed on air force-operated A400Ms, the type's participation at this year's show will be restricted to a static-only visit to be made by production-standard "Grizzly" test aircraft MSN6.

REDUCED EXPOSURE

The A400M tragedy has taken the gloss off several recent sales, selection and programme successes elsewhere within the military transport unit, which would otherwise have received more exposure at the show.

Also assembled in Seville, the Airbus C295 medium transport continues to perform strongly. The company in late March delivered its first example in an enhanced, winglet-equipped version, with the aircraft having been transferred to the Mexican navy.

Supporting improved operating performance in "hot and high" conditions, or providing a 4% improvement in fuel efficiency, "winglets will be standard for all new C295s delivered from now on", the company says, with the update also available as a retrofit option.

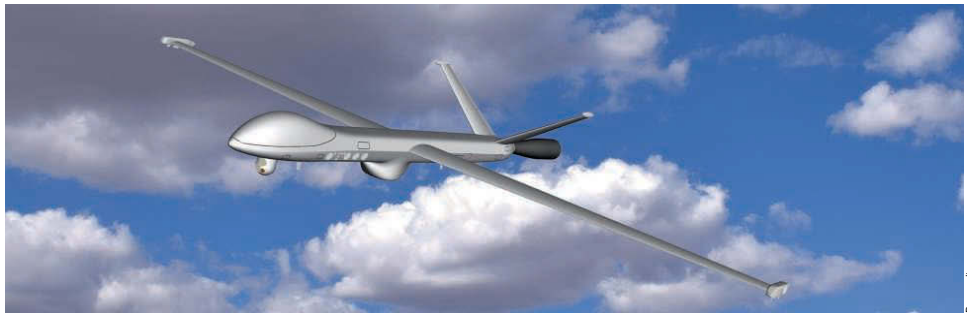
In May, India's Defence Acquisition Council announced its intention to advance with what will be the largest single order to date for the twin-engined C295, with the nation's air force to acquire 56 examples under an "Avro" replacement deal. The aircraft will replace the service's obsolete inventory of HS 748 transports.

While still requiring final sign-off from New Delhi's Cabinet Committee on Security, the deal should proceed under the guidelines of the "Make in India" procurement mechanism. This would see Airbus deliver 16 aircraft from its San Pablo final assembly line, with Tata Advanced Systems to be responsible for completing the remainder.

"This will include undertaking structural assembly, final aircraft assembly, systems integration and testing and management of the indigenous supply chain," the Indian company said when its teaming agreement with

Airbus Defence & Space

In March, Airbus delivered its first enhanced, winglet-equipped C295 to the Mexican navy


Dassault

Airbus and partners have pitched the MALE 2020 for Europe's future UAV requirement

» Airbus was announced last October. Its chairman, S Ramadorai, described the partnership as "a landmark for the development of aircraft manufacturing capability in India".

Flightglobal's Ascend Fleets database records 126 C295s as being in current active use, with these flown by operators in 19 nations.

Other current campaigns involving the type include Canada, where the Pratt & Whitney Canada PW127G-engined model is being promoted to meet a requirement for new fixed-wing search and rescue aircraft. Competition will come from rivals including the Alenia Aermacchi C-27J and Lockheed Martin C-130J.

> **"We have not been performing at the level which had been expected of us"**
>
> **BERNHARD GERWERT**
> Chief executive, Airbus Defence & Space

Business also continues to be strong for the Airbus A330 multirole tanker/transport (MRTT). Currently operated by the air forces of Australia, Saudi Arabia, the United Arab Emirates and the UK, the widebody is also on order for Singapore and has been selected by France, India and Qatar. A group of nations including Belgium, Germany, Luxemburg, the Netherlands and Poland also intends to acquire a fleet of the aircraft under an initiative supported by the EU and European Defence Agency, while the type is being offered to meet a tanker requirement with South Korea.

FULL CAPABILITY

The MRTT is now delivering air-to-air refuelling and passenger transport services for the RAF as the Voyager, while the Royal Australian Air Force's fleet has been in use supporting operations in the Middle East. Canberra has acquired five of the type, which is now close to delivering full capability, as its advanced refuelling boom system has entered clearance testing, initially involving having a second example – referred to locally as the KC-30A – acting as a receiver.

Airbus's long run of sales success with the A330 MRTT will come under pressure from Boeing's 767-based KC-46A, as that model moves through its development and flight test phase for the US Air Force.

But another potential military application for the European type emerged earlier this year, when it was identified as the preferred choice for the airborne warning and control system India (AWACS India) programme. On 25 March, the nation's Defence Acquisition Council approved a planned allocation of over €750 million to acquire two of the surveillance aircraft.

Being led by the Bengaluru-based Centre for Airborne Systems – part of the Defence Research and Development Organisation – the AWACS India activity is eventually expected to deliver six aircraft, each equipped with a 10m (33ft)-diameter antenna rotodome and onboard operator stations.

Meanwhile, Airbus and its industrial partners BAE Systems and Finmeccanica are facing increasing pressure to secure fresh international sales of the Eurofighter Typhoon. Having tasted defeat in India at the hands of the Rafale – although an anticipated 126-aircraft programme has shrunk to potentially only an initial batch of 36 – the Eurofighter consortium has also recently seen Qatar order 24 of the French type, while Kuwait appears set to acquire F/A-18E/F Super Hornets from Boeing. Several Typhoon campaigns are ongoing with nations including Indonesia and Malaysia.

The Eurofighter consortium's most recent export success was a December 2012 order agreed via the UK government to supply a dozen examples to Oman. Under current deals and at the present build rate, production would draw to a close late this decade unless further customers are secured.

Eurofighter will not be exhibiting at the show in its own right; rather through Airbus's presence, but consortium officials continue to speak confidently of the market impact that future capability enhancements, including an active electronically scanned array radar and new and expanded weapons capabilities, will have in attracting further buyers.

GOVERNMENT BACKING

A higher profile at this year's show will be given to a proposed tri-national unmanned air vehicle project involving Airbus Defence & Space, Alenia Aermacchi and Dassault. Proposed by the partners two years ago, the joint development of a future medium-altitude, long-endurance type recently received the backing of the French, German and Italian governments.

Under a declaration of intent signed on 18 May, the companies will complete a two-year assessment phase activity, which is intended to inform subsequent development and production decisions. If the multinational proposal succeeds where other previous initiatives – such as those for the suggested Euromale and Talarion platforms – have foundered, the nations could field equipment from the early 2020s.

To showcase its current work in the UAV arena, Airbus will also be exhibiting the Harfang system now flown by the French military – a development of Israel Aerospace Industries' Heron 1 – in addition to its Tanan unmanned rotorcraft. ■


Commonwealth of Australia

The Royal Australian Air Force is close to making use of the A330's refuelling boom

FIGHTING BACK

Dassault had struggled to find export interest in Rafale despite the type's operational success, but orders from Egypt and Qatar have given the programme new momentum

Dassault

Egypt's order for Rafales was a huge boost for the programme. The purchase continued the country's history of buying Dassault strike types

BETH STEVENSON LONDON

Dassault Aviation's flagship fighter – the multirole, twin-engined Rafale – has had a successful 2015 to date, with what had once appeared to be a dire export outlook re-energised with a pair of firm contract orders.

The aircraft had previously only been acquired by its domestic air force and navy, and although promises and selections for the type had been made by a number of potential export customers, Dassault was struggling to achieve firm deals for Rafale.

All of this has changed, however, as a February deal from Egypt saw its air force put the stamp on a deal for 24 Rafales. This success was followed soon after by Qatar, which also selected to purchase 24 of the type in April. A contract signature was made in Doha in early May.

France has been fully behind the aircraft. The nation's air force operates 48 two-seater B-model Rafales, and 45 single-seater C models, Flightglobal's MiliCAS fleet database shows. The navy has 35 M-variant maritime single-seaters.

OPERATIONAL EXPERIENCE

Following introduction with the navy and air force between 2004 and 2006 and replacing seven types of aircraft, Rafales have been involved in a number of operations, most recently in counter-insurgency operations as a part of the coalition effort against Islamic State militants in Iraq, and against terrorists in Mali under France's Operation Serval.

It also took part in the operations in Afghanistan and Libya, in 2007-2012 and 2011 respectively, and has deployed to eastern Europe in support of NATO's Baltic Air Policing mission that looks to defend the states of Estonia, Latvia and Lithuania against the threat from Russia.

Yet despite operational success with France, and an involvement in fighter campaigns and competitions the world over, Dassault was struggling to receive orders for the type until Egypt set the ball rolling.

Egypt already operates three Dassault strike types, namely 45 Alpha Jets, 82 Mirage 5s and 15 Mirage 2000s.

"This decision is a continuation of our co-operation that dates back to the 1970s, and has seen the Mirage 5, the Alpha Jet and the Mirage 2000 fly in the colours of Egypt. The Rafale meets the needs of countries that, like Egypt, demand a sovereign air force of the best level," Dassault said on receiving the contract from Cairo.

Qatar is also a seasoned Dassault customer, having previously operated the Mirage F1 and »

» still having 13 Mirage 2000-5s and six Alpha Jets in its inventory.

"This new success for the French team demonstrates the Rafale's operational qualities and confirms the confidence that countries which are already users of the Mirage 2000 have in our company," Eric Trappier, chief executive of Dassault, said at the point of selection.

French President François Hollande said at the contract signing in Doha that despite the initial order only being for 24 of the type, "there may later be an option for further acquisitions of this aircraft".

He added that the reliability and credibility of Rafale has led to Qatar and Egypt selecting the aircraft, while it will be "India tomorrow" and other countries in the future.

Now that these two acquisitions are underway, the focus is centred on the potential sale of the type to India.

SMALLER ACQUISITION

New Delhi has shown interest in the Rafale for some time, but despite having selected the aircraft to meet a $20 billion, 126-unit requirement three years ago, it is now set to only place a 36-strong initial order, bypassing the original large acquisition programme.

In April, Indian Prime Minister Narendra Modi announced during a visit to France that New Delhi had requested 36 Rafales to fulfil what was originally its medium multirole combat aircraft (MMRCA) requirement to replace the Mikoyan MiG-21, although a contract is still pending.

Original requirements for MMRCA would have seen indigenous manufacturer Hindustan Aeronautics (HAL) deliver 108 of the 126-unit order after the first 18 were delivered from France, but doubts were believed to have been cast over Dassault's trust in HAL to be able to complete the aircraft to a reliable standard.

Indian defence minister Manohar Parrikar has since declared that a 126-unit order would be "economically unviable", the Indian press reported in May, undermining the previous government that was said to have "hammered" the programme so that it would never have been finalised.

Parrikar noted a committee has been set up to outline the terms of the contract, and this would be completed in the next two to three months.

> **"This new success confirms the confidence users of the Mirage 2000 have"**
>
> **ERIC TRAPPIER**
> Chief executive, Dassault

Meanwhile, the next target market for Rafale remains to be seen. The total number of exported Rafales would be 84 if the Indian deal comes through, but is down based on original projections that included an additional 90 aircraft for India. Therefore, further sales are going to have to be made to justify keeping the production line going past the 84.

One lost competition was a tender in Brazil that was swooped up in October 2014 by another European design, in the form of the Saab Gripen multirole fighter. This contract will see the Swedish airframer and its local production partner Embraer provide 28 Gripen NGs plus eight two-seat F-model examples under Brasilia's F-X2 programme.

When the Gripen was selected in December 2013, Dassault voiced its disappointment, claiming the use of US-built parts in the Saab design would prove problematic.

"We regret that the choice has gone in favour of the Gripen, an aircraft provided with many items of equipment of third party origin, especially the USA, and that does not belong to the same category as the Rafale," Dassault said. "The Gripen is a lighter, single-engine aircraft that does not match the Rafale in terms of performance and therefore does not carry the same price tag.

The French navy has 35 M-variant Rafales

Dassault

"This financial rationale fails to take into account either the Rafale's cost-effectiveness or the level of technology offered," it claimed. The company had also lost out to the Gripen in a Swiss competition, although a public referendum finally derailed that Saab victory.

Malaysia's multirole combat aircraft contest, for which the Rafale is among the candidates, could still prove fruitful for the French manufacturer. Competition comes from familiar rivals in the Boeing F/A-18E/F Super Hornet, Eurofighter Typhoon and Gripen. Once advanced, the long-awaited deal will provide replacements for the Royal Malaysian Air Force's 10 obsolete RAC MiG-29s.

MEETING REQUIREMENTS

Canada has selected the Lockheed Martin F-35 Lightning II, but it is not definite that the current requirement for 65 of the type will be made.

Ottawa appears to be keeping an open mind in its selection of aircraft to replace its 101-strong fleet of Boeing CF-18s – including training assets – and rivals to the type are being pitched by manufacturers in the hope that an alternative will be selected.

In 2014, the Canadian government compared four aircraft – the F-35, Super Hornet, Rafale and Typhoon – in its Evaluation of Options for the Replacement of the CF-18 Fighter Fleet report, which concluded that all types were low-risk replacements when assessed on their ability to carry out six mission sets that would be required to defend Canadian airspace. These included responding to international events such as the Olympics, against a terrorist attack, for peace enforcement, humanitarian disaster relief and state-on-state war fighting.

India's order for Rafales is expected to be substantially smaller than the original requirement suggested

Rex Features

France is working on an upgrade that will allow for new weapons and equipment integration

Dassault

All aircraft were deemed low-risk offerings for performing each mission up to 2030 and beyond, except in fighting another peer nation. In that category, all the aircraft were deemed a higher risk platform beyond 2030 and none distinguished itself, but this mission was dismissed as highly unlikely by the government.

A radar upgrade for the Typhoon, meanwhile, has added market worth to the Eurofighter, which could challenge further exports of the Rafale.

Eurofighter partner nations Germany, Italy, Spain and the UK agreed last November to complete the development and integration of an active electronically scanned array (AESA) radar for the type.

The development will lead to the $1.2 billion completion of work on the Euroradar consortium's Captor E-Scan, and is expected to provide more export potential for the Typhoon. The UK is also advancing a Selex ES-led development of a nation-specific AESA system for potential integration with some of its Typhoons, having signed a £72 million ($110 million) deal for the work earlier in 2014.

"The signing of this contract is a massive boost to all of us and is a pivotal moment," Eurofighter consortium chief executive Alberto Gutierrez said.

While the Rafale already operates an AESA radar in the form of the Thales RBE2 – which Thales claims is the first European combat radar with the electronic scanning capability – the export boost that this potentially offers Typhoon will make it far more competitive, and is pivotal at a time when both types are at similar levels of export success. Eurofighter sales confirmed for non-programme nations currently total 99 aircraft, for Austria (15), Oman (12) and Saudi Arabia (72).

In addition to the radar, Thales also supplies the Spectra electronic warfare system, optronics, communication and navigation systems, an identification suite, avionics and power-generation systems for the Rafale. This amounts to approximately 25% of the total value of the aircraft, the electronics provider says.

NEW WEAPONS

On the developmental side, in early 2014 the French government approved the $1 billion upgrade of the Rafale to a new F3R standard that would allow for new weapons and equipment integration.

This includes the integration of MBDA's Meteor beyond visual-range air-to-air missile and the Sagem AASM "Hammer" air-to-surface guided munition, earlier versions of which were used during France's operations in Libya and throughout Operation Serval.

Under this development effort, in April a French team successfully tested Meteor against an airborne target from a Rafale.

Supported by personnel from France's DGA defence procurement agency, Dassault and MBDA, the 28 April firing was performed from a Rafale B operating from the Cazaux flight test centre. The DGA expects production rounds for aircraft flown by the French air force and navy to be delivered by 2018.

The newest iteration of Thales' PDL-NG laser designation pod will also be added to Rafale, which is subject to a separate development contract awarded by the DGA. Risk-reduction activities on the pod were conducted throughout 2013, and Thales says it aims to begin series production in 2018 in line with the weapons upgrades; the PDL-NG is designed to be integrated with both the Rafale and the legacy Mirage 2000D.

Separately, a "heavily armed" Rafale, integrating the AASM, Meteor and MBDA Mica air-to-air missiles, as well as auxiliary fuel tanks, underwent testing in 2014.

During preliminary evaluation sorties, the aircraft carried six "Hammers", four medium- and long-range Micas and a pair of Meteors on 12 of its 14 external hard points. It was also equipped with three 2,000 litre external fuel tanks.

The self-funded effort was conducted in collaboration with the DGA, and will "eventually lead to a complete clearance of the flight envelope", according to Dassault.

The company claims that the work to enhance Rafale's capabilities demonstrates the type's versatility, while arguing that a pair of the aircraft "represent the same potential as six Mirage 2000-class aircraft".

The C and M variants of Rafale will both be on display by Dassault during the Paris air show, while the French military will display two Rafales as well as a Mirage 2000. ■

STAR PERFORMER

ESA has proven its mettle over the past year, with high-profile achievements such as Rosetta underpinned by a focus on the long-term future of Europe's space programme

DAN THISDELL LONDON

By any standard, the European Space Agency enjoyed a glorious year in 2014. If anybody remained in any doubt as to its ability to pull off the technically fantastic, the Rosetta mission put an end to it. After a 10-year, 6 billion km (4 billion mile) journey involving five trips around the Sun, three slingshot fly-bys of Earth and a fourth of Mars, the spacecraft made global headlines when, as planned, it "woke up" in January after 31 months in power-saving deep-space hibernation before continuing to close on its comet target.

Rendezvous in August – with increasingly stunning pictures of comet 67P/Churyumov-Gerasimenko – followed by a pinpoint lander mission kept the awe factor bubbling; the fact that the lander did not quite cling on to its low-gravity landing pad and bounced into shade that left its solar panels dark was a partial disappointment for the scientists, but left no perceptible dent in broader public delight with what head of mission operations Paolo Ferri called "a really cool mission".

As hard acts to follow go, Rosetta is going to take some beating – and it's still turning in great pictures and a comet-sized mountain of data, expected to shadow 67P until about year-end.

Such a feat understandably overshadowed more mundane but still dazzling accomplishments. The final automated transfer vehicle mission, ATV-5, arrived at the International Space Station (ISS) in August 2014, laden with supplies and demonstrating pinpoint precision in fully-automatic docking. A string of perfect Ariane 5 launches has continued a run that now stands at 65 in a row.

During 2015, Rosetta has held its place in the news; the main mission continues to perform wonders, and hopes remain that its lander, Philae, may harvest enough sunlight to coax its batteries back to life. But Europe's real star turn has been Samantha Cristoforetti; the Italian air force captain-turned-astronaut has been a social media sensation, attracting 493,000 Twitter followers. No harm, then, that her planned December 2014 to May 2015 stint aboard the ISS was extended by a month when a Russian supply mission failure triggered a launch hiatus.

NEED FOR SPEED

Where ESA has really shone in recent months, though, is in its vision for the future. A bid to master hypersonic re-entry got a boost in February, with the successful suborbital flight of a wingless testbed designed to validate heat shielding and control technologies that will feed into a follow-on programme to develop a reusable, autonomous runway-landing spaceplane.

The Intermediate eXperimental Vehicle (IXV) lifting body craft – about 5m (16ft) long, weighing 2t and heavily wired up with sensors – flew from French Guiana atop ESA's small rocket, Vega, for a suborbital test run to a Pacific Ocean splashdown.

The results will feed the Programme for Reusable In-Orbit Demonstrator for Europe (PRIDE), which could fly as early as 2018, also atop Vega. Ultimately, ESA's objective is to be able to bring material back from space, including possibly from asteroids or even Mars.

This year has also seen a milestone reached in Europe's much-delayed plan to establish its own, civilian-controlled satellite navigation capability. A successful 27 March launch, by Soyuz rocket from Kourou, of Galileo satellites number seven and eight, marked the start of what is hoped to be a six-per-year fast track deployment run of what will eventually be a 30-unit constellation. Another dual launch by around year-end will put the European Com-

Italy's Samantha Cristoforetti shared her time aboard the ISS with 493,000 Twitter followers

European Space Agency

mission, which is paying for the programme, in a position to begin offering initial commercial services.

And the launch also coincided with good news about Galileo units five and six. Launched in 2014 but left in what looked to be useless orbits by a rocket misfunction, they have in the end been coaxed into serviceable positions.

LONG-TERM VISION

For European ambitions in spaceflight – and its exploitation of space technology – what is probably most significant is the fact that 2015 is seeing a continuation of a political and financial momentum that, it is fair to say, is ensuring that Europe in space is defined not by headline missions but by long-term vision. The closing act of 2014 was a vote of confidence from the governments of ESA's member states, who – despite their very terrestrial financial struggles – have clearly decided that space is valuable. Meeting in Luxembourg to set priorities, and spending commitments, technology and industry ministers backed science, infrastructure and launch capability.

The Luxembourg meeting guaranteed full funding for ESA's two ExoMars missions, to launch in 2016 and 2018, and gave a second-stage green light to the Ariane 6 programme. This looks to replace the hugely reliable but expensive Ariane 5 launcher with a more cost-efficient rocket from about 2020 or 2021; technical details of the all-solid, modular launch system should be revealed imminently.

Demonstrating the extent to which Europe's political leadership sees economic and strategic value in maintaining independent, competitive access to space, a proposal by Airbus Defence & Space and Safran to form a joint venture to consolidate the Ariane programmes and streamline the European launcher programme's industrial structure also got the nod, with the details being worked out through 2015, alongside technical work on the new rocket system. Ariane 6's solid-fuel and modular design should be a major step forward, streamlining the production of rockets and bringing new flexibility to launch campaigns. But all parties recognised that the engineering plan could not realise its cost objectives without the overhaul of a rocket-building ecosystem designed to spread work across a dozen countries – a product of European consensus politics rather than any industrial sense.

So, in a sense Europe is now facing its greatest challenge in spaceflight. Ariane 5 is the world's leader in the lucrative market for telecommunications satellite launches, and provides invaluable access to space for even the biggest payloads, but it faces fierce commercial pressure from SpaceX's Falcon 9 and, in the coming decade, from a new modular concept recently unveiled by the Boeing-Lockheed Martin joint venture, United Launch Alliance.

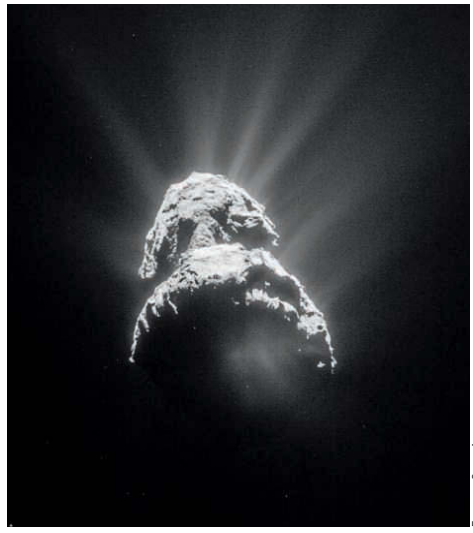
European Space Agency

The Intermediate eXperimental Vehicle enjoyed a flawless launch from Kourou, French Guiana

Where ESA has really shone in recent months, though, is in its vision for the future

The coming months will be critical; Airbus and Safran need to show that their joint venture can come together, and Europe's politicians need to maintain the will to stand aside and leave the private sector to drive the project. To a great extent, it will be down to the European Commission to ensure that Ariane 6 remains depoliticised.

And, another significant transition is imminent. ESA director general Jean-Jacques Dordain will retire on 30 June after more than a decade in the job, and be replaced by Johann-Dietrich "Jan" Wörner, head of Germany's DLR aerospace agency since 2007. Dordain has been a most able leader and will be missed for his political skills as much as his mission focus, not to mention his endearing sang-froid. However, Wörner is the obvious choice to replace him – and a good one, given his ability to marshal a wide range of resources from many partners.



European Space Agency

Rosetta captured stunning images of the comet

PUBLIC ROLE

Wörner believes nothing substantial can happen without public engagement; the key to progress is for politicians, scientists, engineers, business people and organisations like DLR and ESA to recognise the public is a driver of technological solutions, not just a receiver.

Wörner's stewardship also promises to continue Dordain's legacy of an ESA which shows the way when it comes to realising projects that rely on deep-rooted, reliable collaboration – such as the International Space Station or, ultimately, any human missions to Mars.

In space, then, Europe is on a roll. Nothing actually rolls in space, of course, except maybe a Mars rover – and Europe's is rolling along just fine, driving toward the next stage in ESA's bid to advance humankind's quest for an answer to the question: "Is there life on Mars?"

When the 2015 Paris air show opens, the cleanest clean room in Europe will be approaching completion, at Airbus Defence & Space in Stevenage, UK. Clean enough to ensure no biological specimens are clinging on for the ride, work should begin early in 2016 on the rover that will fly in 2018 on the second half of ESA's two-stage ExoMars mission.

Meanwhile, ExoMars 1 – an orbiter and a lander, to test entry, descent and landing technology for the 2018 rover arrival – is being prepped for launch in 2016. That mission, to be carried by Russian launches after NASA had to pull out owing to budget cuts, promises to carry on where Rosetta leaves off, pushing Europe's mark into deepest space. ■

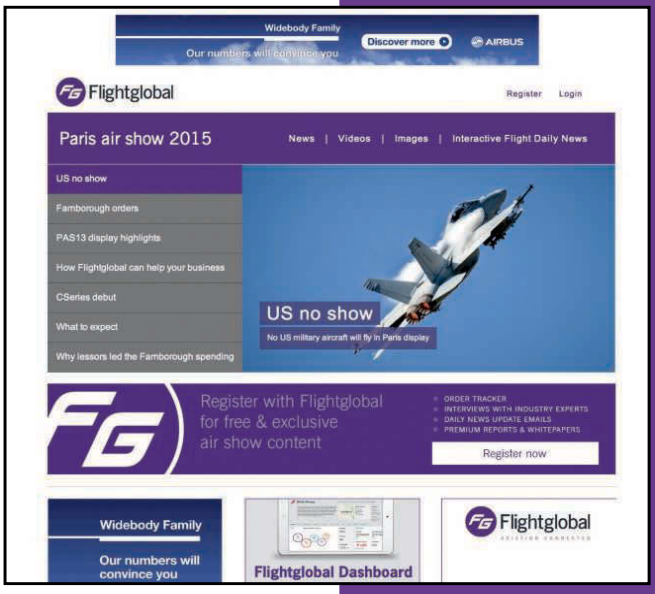
BROADEN YOUR VIEW

SOCIAL MEDIA

For breaking news and instant reaction, nothing beats Twitter, and our journalists will be bringing you the latest developments from the show – and their thoughts on these developments – as they happen via #PAS15. Follow our official account @Flightglobal for all our stories, or individual tweeters such as Stephen Trimble @FG_STrim, Craig Hoyle @FlightAcesHigh or Murdo Morrison, who posts as @Flighteditor

PARIS AIR SHOW LANDING PAGE

Our show landing page at flightglobal.com/paris is your first port of call for all our Paris material. Here you can find our preview pieces on the programmes and topics that will feature at the show, as well as breaking news, images, videos and our special free preview and review editions of our interactive *iFlight* magazine. You can also find out how Flightglobal can help your business, with details of our data, information and consultancy services.

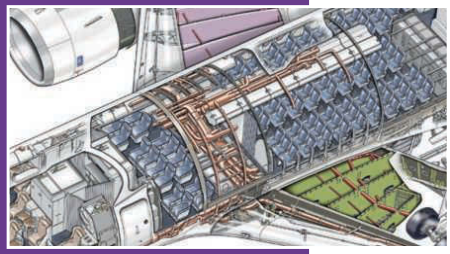


FLIGHT INTERNATIONAL

As well as this bumper special preview edition of *Flight International*, we will also be producing our show report issue from Paris. Available on 23 June in print and on 20 June digitally, the magazine will include about 30 pages of news, analysis and images covering the most important aspects of the four-day event.

BirdPix

No other media group will cover the year's biggest air show as widely and deeply as Flightglobal. Here are just some of the ways you can follow the daily happenings from Paris via the world's leading aviation information brand, in print and online

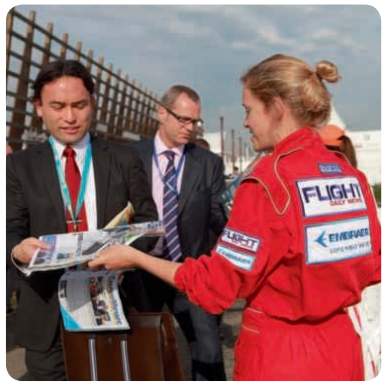


INTERACTIVE MAGAZINE

For the first time, we are producing two free, interactive air show magazines – just before and at the end of the show. A complement to *Flight International* and *Flight Daily News*, the i-mags will have many additional features, including video, graphics and a look at Paris shows from history.

FLIGHT DAILY NEWS

Every morning of the show our red-suited distribution team will be up early to hand out copies of the liveliest, most authoritative and most readable show newspaper to those coming through the gates. Produced live from the show the day before, *Flight Daily News* has been covering Paris and other major air shows for more than 25 years.



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Vulcan roars into its final ever tour

It may have had more comebacks than Sinatra, but this display season really will be the last for the sole surviving delta-winged Vulcan, with the highlight a thunderous appearance at the Royal International Air Tattoo in July.

XH558 – restored in 2007 by the Vulcan to the Sky Trust – has had a remarkable second life of eight years on the air show circuit, longer than almost anyone expected. But this summer, sadly, will be its swansong. Turn up, if you can, to enjoy its final roar.

Vanishing pilots

Odd piece of research – well, one of those pieces of PR that tries to pass itself off as a hard-hitting survey of consumer attitudes – that, if true, does not bode well for the future of the airline industry.

Apparently half of Britons believe commercial aircraft will be pilotless by 2025. Maybe the Great British Public knows something about experiments in autonomous cockpits that Airbus and Boeing have not shared with us yet. But, at the same time, only 3% of them would feel happy flying in an unmanned airliner.

Time to get out of aviation, advises our man in the City, Rex Stocks, who incidentally is being replaced by a piece of software called Brian.

A lot of gull

Ah, the stirring sight of eight Red Arrows in formation. But, wait a minute, why in place of the ninth Hawk is there a vapour-trailing seagull?

Ross Parry /SWNS Group

Arrow arrow: It's a red herring gull

This image by first year photography student Jade Coxon became an internet sensation after she took the chance picture at the Llandudno air show.

She describes spotting the photobombing bird flying into perfect position in the frame as she took the picture as a stroke of "pure luck".

Craig Hoyle/Flightglobal

From the incongruous/optimistic aircraft reg files: we're not quite sure if this Saab 340 quite lives up to its billing

Left behind

If you think that executive perks and all that commission from record orders mean Airbus's John Leahy never has to turn right when he gets on a plane, think again.

In the interests of research, the "world's greatest aircraft salesman" admits to regularly flying coach, on Boeings as well as his own products.

However, Leahy rarely passes an opportunity to diss his rival's product offering. Toulouse's marketing push this year highlights its 18in economy seats versus its competitor's skinnier alternatives.This prompted the generously-proportioned sales supremo to recount a recent trip on a 787.

"I told the operator I was worried I couldn't get into one of their nine-abreast 17in seats," said Leahy. "He replied: 'You can; you just can't get out.'"

Sevens above

Must have been a nice moment for Airbus when its A350 backlog passed a certain milestone – 777.

Ayatollah order

Forget the threat of covert nuclear weapon research or altering the regional power balance, the Iranians have come up with a prospect much more scary: a solar-powered widebody. According to the MEHR news agency, Iran's aerospace research institute is designing such an aircraft to replace the ill-fated IrAn-140 – a licence-built Ukrainian An-140 turboprop. What could possibly go wrong?

Missed missile

Break the speed limit and you can expect to be pulled over by the cops. But drive down a Florida freeway with a 3m Israeli air-to-surface missile next to you in your open-top car, and absolutely nothing happens.

This was the experience of businessman Tom Madden who, as an experiment, loaded the (legally bought and unarmed) missile into his Volvo and drove for several hours without experiencing anything more than a few worried glances from fellow motorists.

Great satisfaction

100 YEARS AGO

If one were to ask the question of the first fifty people one met: "which single feat achieved during the week has been hailed with greatest satisfaction by the general public?" the answer would undoubtedly be "the bringing down of a Zeppelin by Flight Sub-Lieut Warneford, RN".

Fighting on alone

75 YEARS AGO

The world is stunned by news that the French Government has asked Germany and Italy for an armistice. Two thoughts are outstanding in our minds. First, admiration for the glorious fight put up by the French Army, and secondly, determination to stand behind our Prime Minister and Government in their decision that the British Empire will fight on alone, "until the curse of Hitler is lifted from the brows of men".

Callous *Flight*

50 YEARS AGO

When a magazine such as yours adopts such a callous attitude towards the construction of replicas of historic aircraft, it is no wonder that the days of the true enthusiast seem numbered.

Saviour steward

25 YEARS AGO

The captain of a British Airways BAC One-Eleven was badly injured after being blown halfway out of the cockpit during an explosive decompression at 17,000ft on 10 June. He was saved from ejection by a steward who grabbed his legs.

FLIGHT INTERNATIONAL

We welcome your letters on any aspect of the aerospace industry.
Please write to: The Editor, Flight International, Quadrant House, The Quadrant, Sutton, Surrey SM2 5AS, UK.
Or email flight.international@flightglobal.com

The opinions on this page do not necessarily represent those of the editor. Letters without a full postal address supplied may not be published. Letters may also be published on flightglobal.com and must be no longer than 250 words.

Hidden dangers make MA60 risky

Your compilation of the MA60's accident history (*Flight International*, 19-25 May) seems to show that eight of the 13 accidents were likely due to pilot error, so let us not blame this aircraft for the bulk of them.

The latest incident was serious in nature, but despite the horrific impact forces all three gear are intact – something reported in the Merpati accident of June 2013.

Magnetic locks should permit no selection of "Beta" range unless the weight-on-wheels solenoid has unlocked the power levers. But even on relatively new aircraft of this particular type, this circuitry may be intermittently reluctant to permit the power lever "triggers" to release the locks. Just forward of the left power lever is a small, silver plunger (unlabelled), that if raised to the UP position bypasses the safety circuitry and enables unrestricted Beta selection.

If a crew has had difficulties getting into Beta, and landing distance is critical, they might be tempted to bypass the safety provision by simply lifting the plunger, turning it 90° and keeping it in the bypass position.

Because there is no label on this plunger, and no checklist instruction – that I know of – to ensure it is in the correct position, it is possible that an oncoming crew could operate in blithe unconcern that this safety feature was no longer present, having previously been bypassed.

The physical aircraft, thanks to its Antonov ancestry, is rugged enough for the challenges of the developing world, and the PW127 powerplants are superb. Drastic improvements are in order for checklists, flight manuals and above all, flight training.

Name and address supplied

SAFETY

Why block cockpit video use?

Rex Features

'Privacy' is not a valid argument

I agree with former NTSB chairman Mark Rosenker's opinion (*Flight International*, 26 May-1 June) that cockpit image recordings are coming. Pilot professional organisations which have been against this step for so long should note that the legislation which protects cockpit image recordings from disclosure has been there for quite a long time.

ICAO Annex 13 and European Regulation 996/2010 set the same level of protection for cockpit image recordings as for voice or flight data recordings. Can we expect more stringent regulations? I really doubt it.

The "privacy" problem simply does not exist, when pilotseye.tv is mounting cameras in the cockpit observing every move – but this argument pushed forward when there is a question about safety investigation.

Why do we deprive ourselves of powerful instruments such as image recorders to understand what really happened in the cockpit, and emphasise the safety of flying and the passengers' confidence in the most exciting job in the world?

Image recorders are an additional tool, and their real value is when combined with flight data and cockpit voice information.

We have the technology, we have the regulations. Now it is time to start using them to further enhance flight safety.

Yavor Petrov
Bulgaria

Missing detail

I refer to your report 'A320 pilot rehearsed crash settings' (*Flight International*, 12-18 May) and the BEA's preliminary report on the Germanwings flight 4U9525 crash of 24 March.

If the explanation for the sequence during the first sector was some avionics error or fault, it would have been highlighted to the captain on his return to the cockpit, and reported for engineering attention during the transit. For it to recur on the second leg suggests rather strongly that it didn't happen by chance.

There was no mention of whether the captain used the auto-unlock code when trying to gain access to the flightdeck, or whether aviation medical examiners had contacted the authority before an evaluation – as required by the endorsement in the co-pilot's licence.

There were five opportunities, between 2010 and 2014. This was critical, as it provided an opportunity to monitor and track his recovery from a depression episode of 2008-2009.

If it had been done, the report should have stated so – or at the least whether it could not be proven that it was done.

That performance evaluations of both pilots were consistently above average only goes to show that it is impossible to assess one's mental state through one's technical performance.

Like all other tragedies our industry has experienced, in time the right lessons will filter through and we will be the better for it.

Whatever the outcome of the investigation, it is still a senseless, tragic loss. We should be patient for the right conclusions and recommendations to follow up with.

Capt Felix Chen
Singapore

Age barrier

Every day I receive several emails from recruitment consultants clamouring for type-rated, experienced pilots.

Yet, when I try to apply with my CV (Boeing 737, 5,000h-plus) I am excluded, as the age limit for most positions is 45-50.

As someone over 50 I am curious why my flying and life experience is suddenly devalued at a certain age.

Perhaps someone from the industry would enlighten us all?

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Birmingham, UK
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17-19 July
Royal International Air Tattoo
RAF Fairford, Gloucestershire, UK
airtattoo.com

20-26 July
AirVenture Oshkosh
Oshkosh, Wisconsin, USA
eaa.org/en/airventure

25-30 August
MAKS
Moscow, Russia
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15-16 September
Flight Safety Symposium
London, UK
flightglobalevents.com/flightsafetysymposium2015

15-18 September
DSEI 2015
ExCel, London, UK
www.dsei.co.uk/

1 October
US Corporate Aviation Summit
Fort Lauderdale, Florida
aeropodium.com/uscas.html

1-2 October
Central Asian Aviation Symposium
Almaty, Kazakhstan
aeropodium.com/caa.html

6-8 October
Helitech International
ExCel, London, UK
www.helitechevents.com/

20-21 October
The Commercial UAV Show
ExCel, London, UK
terrapinn.com/exhibition/the-commercial-uav-show

8-12 November
Dubai Airshow
Dubai World Central
www.dubaiairshow.aero/

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San Juan, Puerto Rico
alta.aero/airlineleaders/2015

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JUDICIAL PUBLICATION
AT THE REQUEST OF AIRBUS HELICOPTERS

BELL HELICOPTER TEXTRON INC.
AND BELL HELICOPTER TEXTRON CANADA LTD.
HELD LIABLE FOR THE INFRINGEMENT OF FRENCH PATENT N° 96 07156

By decision of 20 March 2015, the *cour d'appel de Paris* [Court of Appeal of Paris], Pole 5, Chamber 2 decided as follows:

"States that the two versions of the landing gear with which the Bell 429 helicopters are equipped copy the features of the claims 1, 2, 4, 5, 7, 8, 9, 10, 13 and 15 of the French patent no. 96 07156, which is owned by Airbus Helicopters, the first version literally, the second version by equivalency,

States that the corporations Bell Helicopter Textron Inc. and Bell Helicopter Textron Canada Ltd. are guilty of infringing claims 1, 2, 4, 5, 7, 8, 9, 10, 13 and 15 of the French patent no. 96 07156, which is owned by Airbus Helicopters, and this, by offering, importing, offering for sale and holding, in France, Bell 429 crafts equipped with the first and second versions of the landing gear that copy the features of the said claims,

Prohibits the corporations Bell Helicopter Textron Inc. and Bell Helicopter Textron Canada Ltd. from pursuing the acts of infringement and order that they refrain from re-offending on pain of a non-comminatory fine of €1,000,000 per offense after a period of two months following service of this decision (…),

Sentences, in solidum, the corporations Bell Helicopter Textron Inc. and Bell Helicopter Textron Canada Ltd. to pay the corporation Airbus Helicopters a reserve of €3,000,000, the final amount of which damages remain to be determined based on an expert report,

Orders confiscation of the landing gear embodying the abovementioned patent held in France by the corporations Bell Helicopter Textron Inc. and Bell Helicopter Textron Canada Ltd. after a period of 15 days following service of this decision, and the destruction of the landing gear under the inspection of a bailiff,

Prohibits the corporations of Bell Helicopter Textron to repair, in France, the landing gear of the Bell 429 helicopters equipped with the landing gear embodying the abovementioned patent, on pain of a non-comminatory fine of €300,000 per offense,

(…)

Sentences, in solidum, Bell Helicopter Textron Inc. and Bell Helicopter Textron Canada Ltd. to pay Airbus Helicopters the sum of €300,000 on the basis of article 700 of the Code of Civil Procedure (…)

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WORK EXPERIENCE SCOTT ROGERS

Creating committed relationships

President and founder of Atlanta-based Amjet Aviation Scott Rogers works as a business jet broker and advisor, and has completed transactions in more than 35 countries for a range of corporate and high-net-worth clients

When did you start your career in aviation?
It was in 1975, with my family's formation of Laurel Flying Service as a fixed-base operation, that my first real work responsibility began. I initiated an expansion of services from fueling aircraft to include aircraft charter, management, flight training and maintenance. I successfully expanded our aircraft sales to become a leading dealer of pre-owned Beechcraft piston/turbine airplanes, thereby generating additional revenues from a global market.

You left service behind?
I sold the company's service and operational assets in 1986 to focus my sole attention on expanding our aircraft sales volume. The management experience with the aviation services was very influential in my educational path as well as my career path. I realised the need for a formal education along with real-world business experience. This led to my decision to complete my bachelor's degree in business and then subsequently my coursework for an MBA. It was the overall knowledge gained in providing aviation services, aircraft operations and aircraft sales that prepared me for where I am today. This broad-base knowledge of aviation is required to provide superior and comprehensive professional marketing, acquisition and consulting services to business jet owners.

Amjet Aviation

Rogers combines industry experience with a broad business education

Why did you launch Amjet?
I founded Amjet Aviation as an affiliate of the original company in order to better define the growth and brand as a leading provider of professional aircraft brokerage and business aviation advisory services for a global client base focused solely on business jet aircraft. Amjet Aviation's goal is to provide the best possible representation to our clients. We subscribe to the basic idea that absolute commitment to our clients will develop valued, long-term relationships, resulting in a better firm with substantial improvements in our performance.

We are not limited in our geographic range, given the mobility of the aircraft we market. We have completed transactions in more the 35 countries but we do place an emphasis on the US domestic and European markets, which make up 70% and 30% of our client base, respectively.

How do you stay competitive in a crowded field?
We provide a unique expertise along with understanding and support of individual client needs. It is our reputation for absolute commitment to clients which inspires valued long-term relationships. This basic principal has led to unmatched client satisfaction. Corporate and high-net-worth clients value this dedicated relationship throughout their aircraft ownership from the time of purchase, operation and eventual re-sale or upgrade of their jet aircraft. Our level of professional expertise cannot be matched by many of the competing firms and brokers, many who are recent entries into the aircraft brokerage business.

It can be extremely hard to succeed in business jet sales and brokerage. You have to successfully market yourself and your professional ability with every new prospect before you ever get a chance to sell an aircraft. This can be difficult for many people since obtaining an aircraft listing and then selling the aircraft require two very different talents.

How has business been since the recession?
The recession of course was negative for all markets but slow economic recovery has resulted in continued declining values of pre-owned aircraft. Pre-owned activity did improve in 2014 but most of this activity was driven by lower prices. The new models of ultra-long-range aircraft such as Gulfstream's G650 remain very strong. There is also demand for the new Bombardier Global 7000, which is in development with some early delivery positions already selling for substantial premiums. ■

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